Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

DECEMBER, 1950

TECHNOLOGY DEPT.

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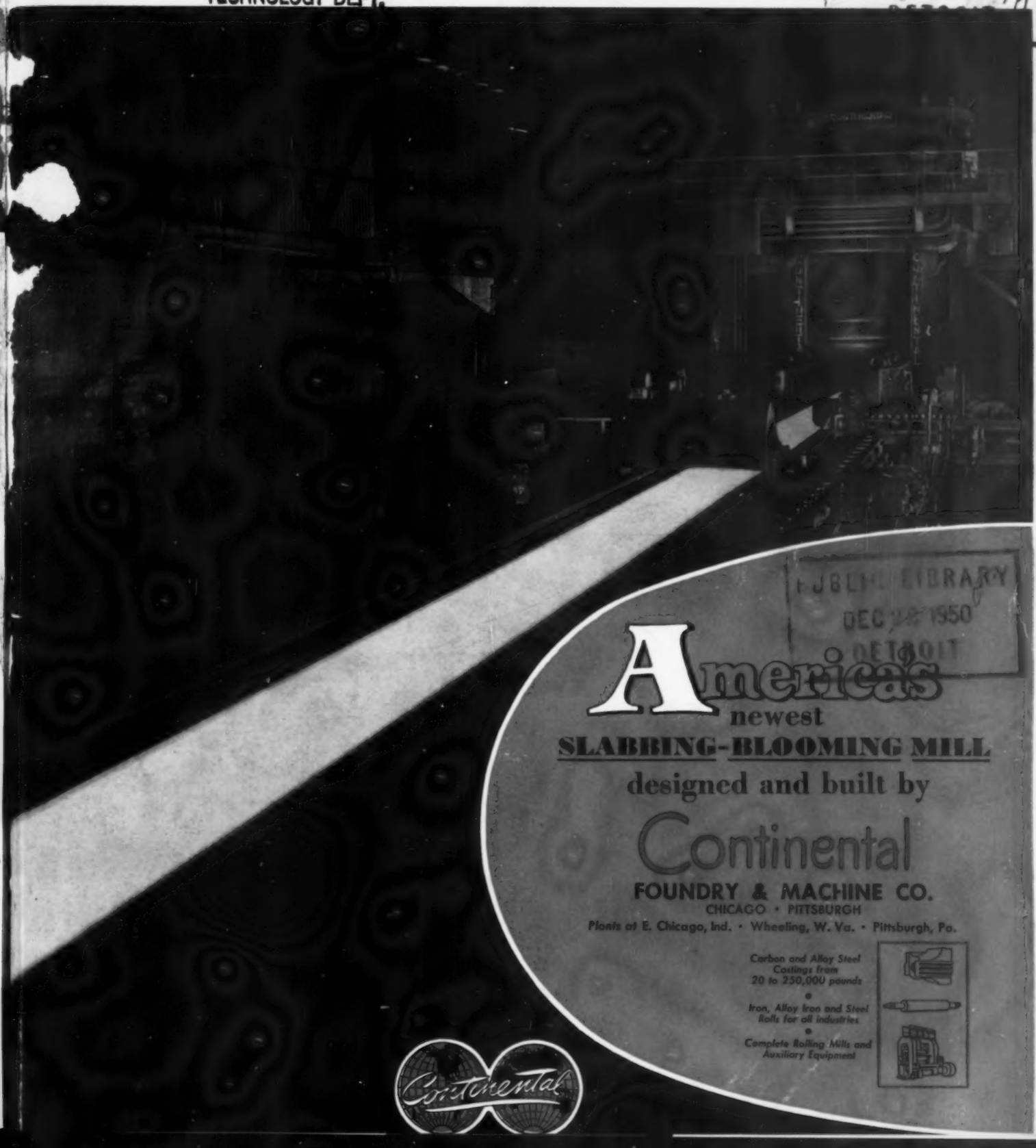
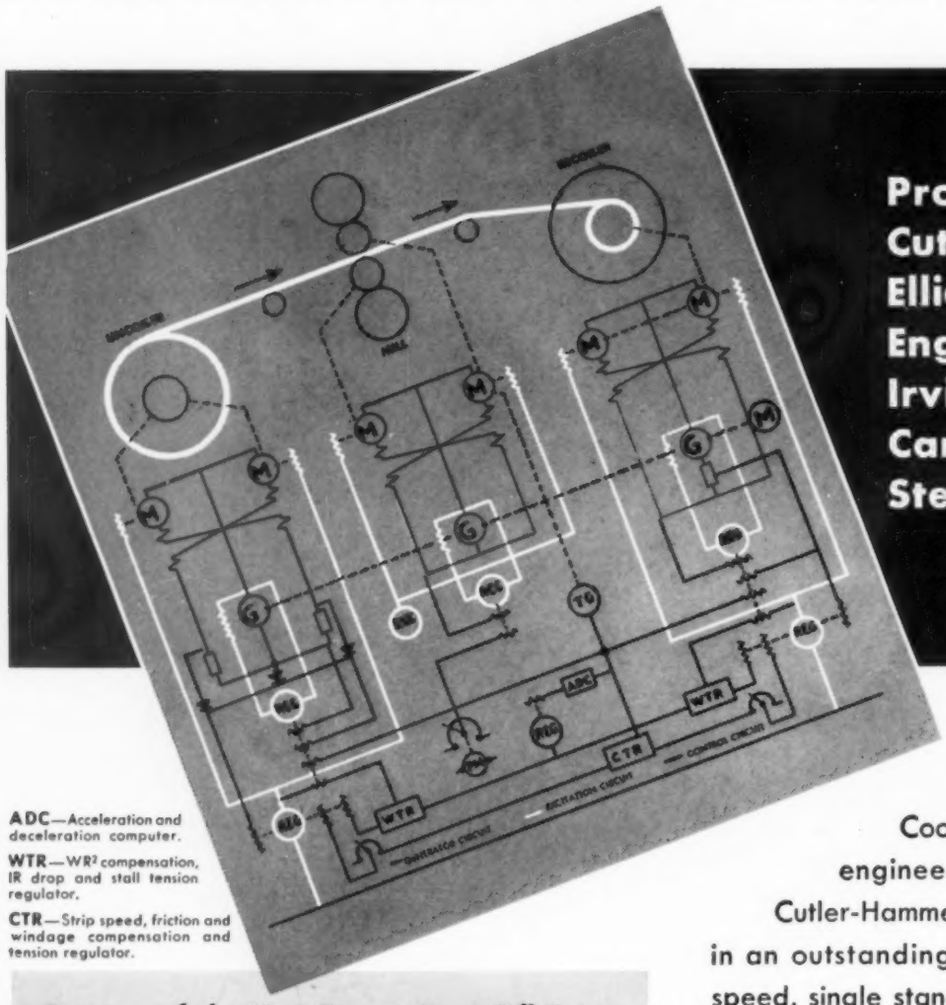

PUBLIC LIBRARY
DEC 23 1950
DETROIT
Americas
newest
SLABBING-BLOOMING MILL
designed and built by
Continental
FOUNDRY & MACHINE CO.
CHICAGO • PITTSBURGH
Plants at E. Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.
Carbon and Alloy Steel Castings from 20 to 250,000 pounds
Iron, Alloy Iron and Steel Rolls for all industries
Complete Rolling Mills and Auxiliary Equipment
Continental

Modern high speed temper mill drive maintains accurate tension at 2500 F.P.M.



ADC—Acceleration and deceleration computer.

WTR—WR^2 compensation, IR drop and stall tension regulator.

CTR—Strip speed, friction and windage compensation and tension regulator.

Produced by Cutler-Hammer, Elliott and Reliance Engineers for the Irvin Works, Carnegie-Illinois Steel Corporation

Features of the New Temper Pass Mill Drive

All operations are performed from an operator's cabinet at each end of the mill. Threading the strip through the single stand mill is accomplished in minimum time. Strip tension between mill and reels is then regulated to any desired value by means of the Reliance VSA current regulating exciters of each reel. By proper adjustment of the compensation for IR drop, friction, windage, and strip speed, the tension may either be held constant or tapered as required to provide a uniform quality of the processed strip. Any change in reel motor current and thus the tension, is translated to the VSA regulators which immediately modify the reel motor fields in such a way as to re-establish the tension. Sudden transient requirements of a wider current modification are also translated to the VSA voltage regulators of the reel generators which immediately respond to assist in establishing the desired current. The required change in current and torque when accelerating and decelerating is measured by a WR^2 compensating device which responds to actual rate of change in speed of the mill and thus insures the proper compensation with any rate of acceleration.

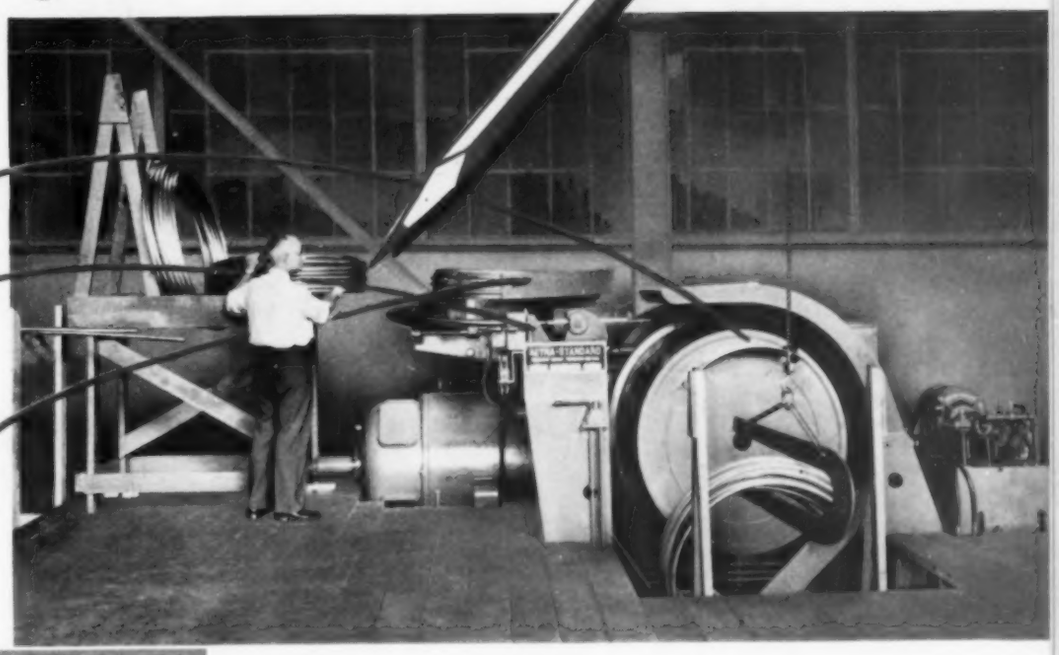
Cooperative efforts between the engineers of the Elliott Company, Cutler-Hammer and Reliance have resulted in an outstanding development . . . the high-speed, single stand temper pass mill drive. The speed of the mill has been stepped up from 500 feet per minute to 2500 feet per minute with provisions for 3750 feet per minute in the future. Other operating features of this drive are described in the box at the left. In the greater production of high quality steel from this mill, you will find a hint why you should consult Cutler-Hammer Mill Control Engineering experience. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879 $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 27, No. 12.

NEW! horizontal Bull Block for Tube drawing...

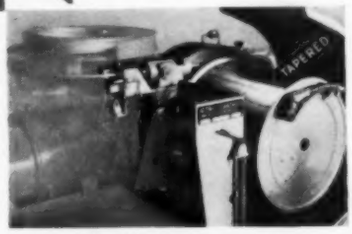


Coil Payoff

To facilitate handling of tubing at the entry end, Aetna equips the machine with a coil payoff of special design. The unit is integral with the Bull Block.

Shear Push Pointer and Die Block

Shear cuts off trailing end of tube during drawing operation . . . without stopping block. Hydraulic push pointer with integral die box points tubing just prior to drawing. Use of push pointer and shear eliminates manual handling of coil between draws.



Coil Unloading

To eliminate need of coil push-off, the Bull Block is equipped with a tapered drum. When draw is complete, the tapered design enables operator to unload coil with ease.

● This Bull Block has a distinct production advantage—continuous operation. The push pointer and the shears, integral in the unit, point and crop material in motion. No stopping or starting until cycle has been completed.

Note these other features of the new Aetna Bull Block:

Improved handling of tubing up to and away from the Bull Block.

Draw from either straight tubing or coils.

Circulating lubricating unit provides continuous lubrication at the die.

Simplified design lowers original cost and insures low maintenance.

Standard equipment includes crop shear and push pointer.

Aetna-Standard designs and builds high production equipment for tube drawing from billet to finished tube, including Piercing Mills, Hydraulic Squeeze Pointers, Drawbenches and Bull Blocks. Call on Aetna-Standard's specialists.

Only completely equipped one man Bull Block available

aetna-standard

THE AETNA-STANDARD ENGINEERING COMPANY · YOUNGSTOWN, OHIO

Plants in Warren, Ohio · Ellwood City, Pennsylvania

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

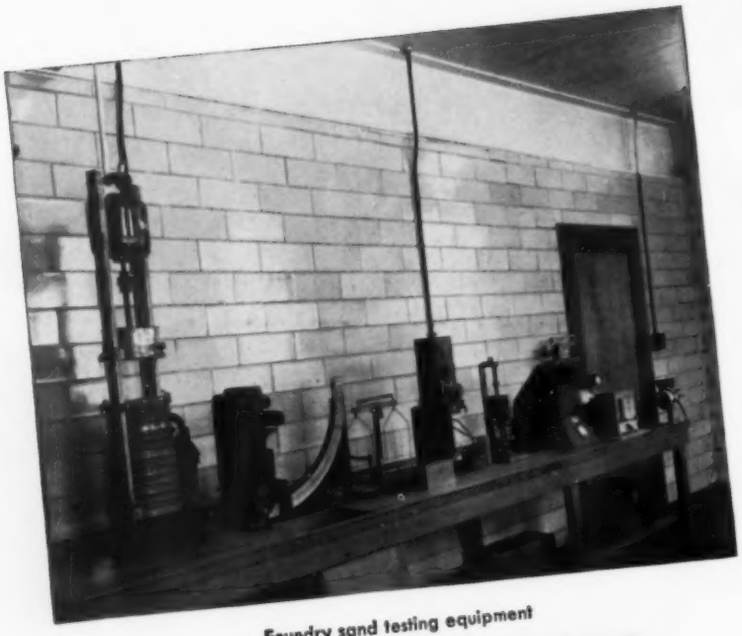
Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

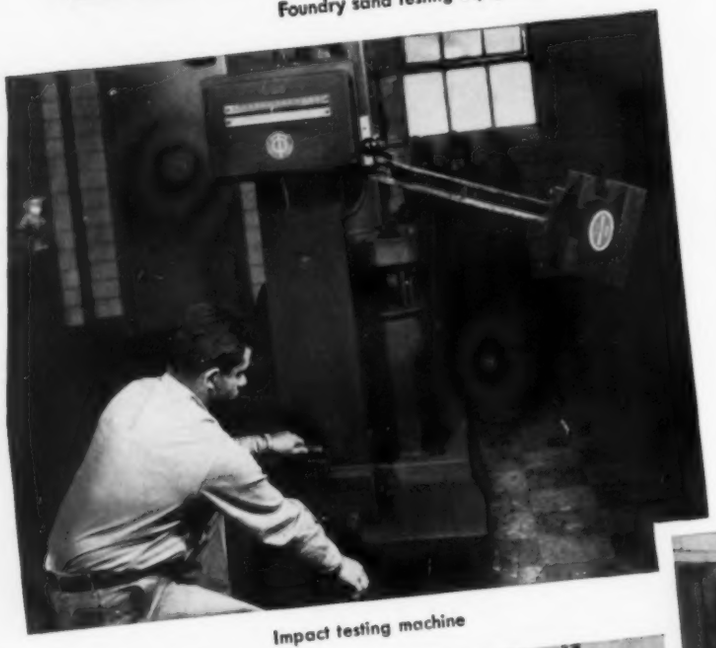
Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

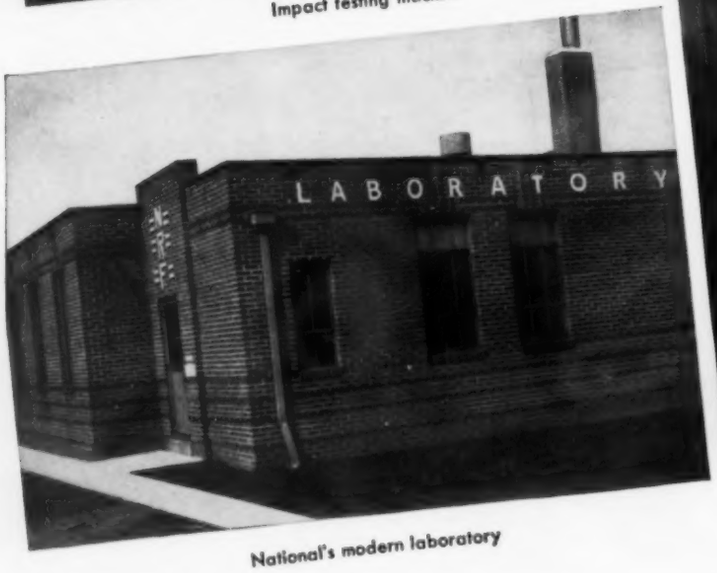
Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries



Foundry sand testing equipment



Impact testing machine



National's modern laboratory

How Physical Properties are controlled at National

...to bring You better rolls

In the production of every roll at National, exacting quality control is maintained through constant laboratory analyses. In the physical laboratory, castings are subjected to rigid tests to be sure that they meet exact specifications.

Composition, heat treatment, hardness, chill depth and other characteristics are carefully charted and indexed for each job.

You are thus assured of rolls that have sound physical properties and that live up to your expectations for long tonnage life when you specify "National".

THE NATIONAL ROLL & FOUNDRY CO.

Avonmore, Pennsylvania

SPECIALISTS IN
IRON AND ALLOY IRON ROLLS AND CASTINGS

Tensile testing machine

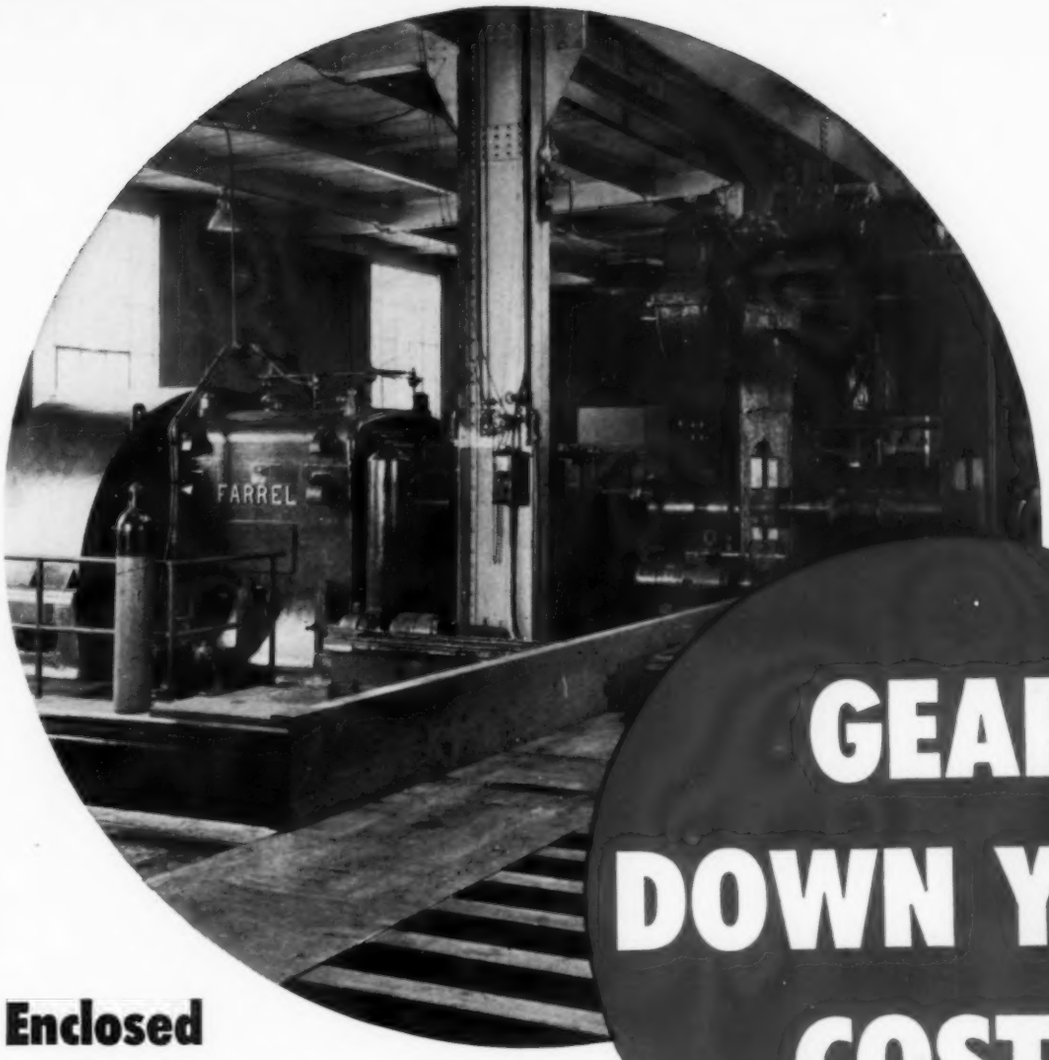


Photo courtesy
Farrel-Birmingham Co., Inc.
Ansonia, Conn.

GEAR DOWN YOUR COSTS

Enclosed reduction gears run better, last longer, with TEXACO MEROPA LUBRICANTS

THERE'LL be no gnashing of teeth when *Texaco Meropa Lubricants* are on the job. These "extreme pressure" lubricants are especially designed to resist the heaviest "squeeze," give gears and bearings full protection . . . assure smoother, quieter operation.

Texaco Meropa Lubricants combat oxidation and thickening, and guard bearings against corrosion. They do not foam, and will not separate in service, storage, or centrifuging. All these benefits add up to greater efficiency, longer gear life and lower maintenance costs.

To assure full protection for your oil film roll necks, use *Texaco Regal Oils*. These famous turbine-grade heavy circulating oils resist oxidation, emulsification and sludging. They keep oil lines clean . . . bearings fully lubricated.

A Texaco Lubrication Engineer will gladly show you the way to greater efficiency and economy through effective lubrication. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

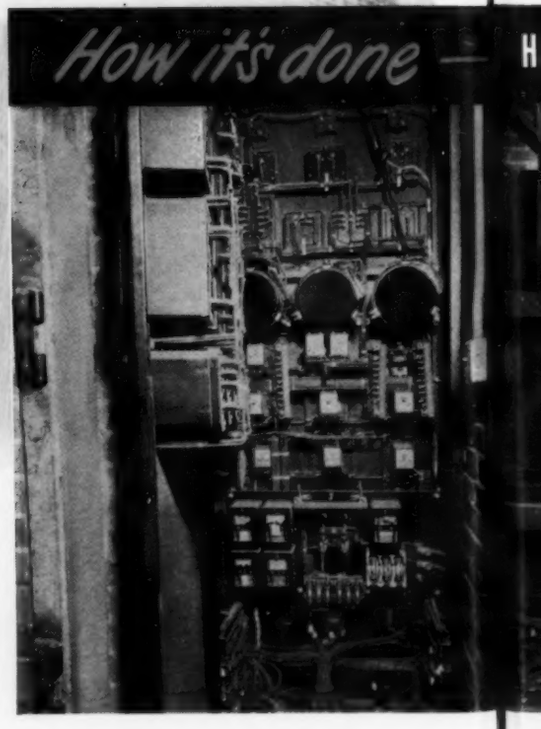
TEXACO

TEXACO Meropa Lubricants
FOR STEEL MILL GEAR DRIVES

TEXACO presents MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA radio broadcasts every Saturday afternoon.

Westinghouse

EQUIPMENT FOR THE STEEL INDUSTRY



Furnace Control with Optimelt-Control feature maintains the arc in its most economical phase. No power is wasted; the proper amount is supplied *when* it's needed. Write for IB 31-280 CS-1 and CS-2.

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

OUTPUT BOOSTED 5%— AND LESS POWER USED!

Here's news whether or not you're interested in electric furnaces right now. Because the same feel-for-steel engineering that made these remarkable improvements is available to help make your next job better, whatever it is.

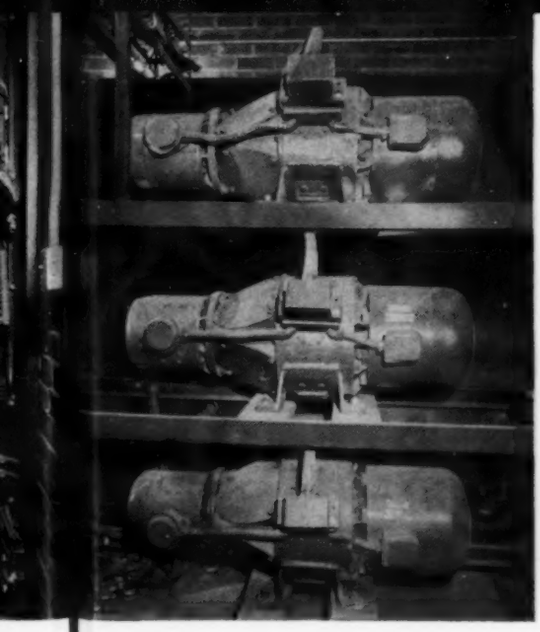
To determine the precise superiority of Westinghouse Optimelt-controlled electric furnaces, one major steel producer pitted them against identical furnaces with manual control. The mill dug up its own proof in a seven-month-long check of actual operations.

Under identical charge conditions, the Westinghouse-controlled furnaces made *5% more steel per furnace hour.* Yet they actually used 2½% less power per ton of steel poured. And they cut electrode consumption and reduced furnace delays.

This is the kind of dollar-saving engineering that Westinghouse applies to steel mill electrical equipment. When you're planning your next installation, call in Westinghouse early. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

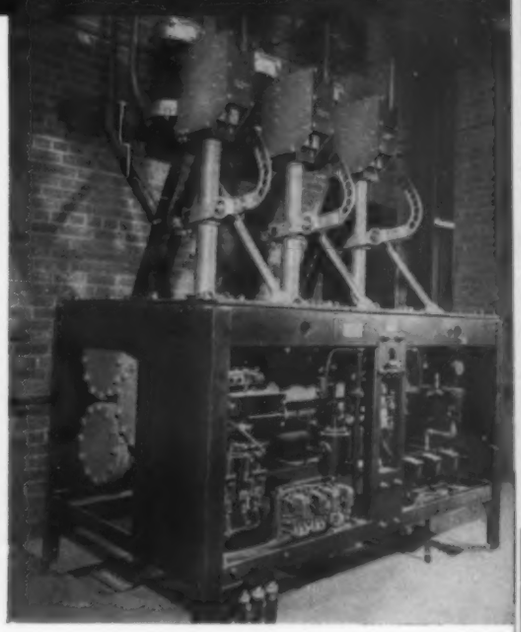
J-94846

HERE'S THE EQUIPMENT BEHIND THE SUPERIORITY OF (W) -CONTROLLED ELECTRIC FURNACES



Rototrol Regulator positions electrodes quickly, accurately, and *automatically* as furnace conditions change. Shown above: M-G sets for positioning three electrodes with Rototrol unit mounted at left end of each.

Furnace-type Transformer continually transforms main mill power for exacting furnace requirements. Transformer is built in shell construction for maximum bracing strength and optimum cooling conditions.



Compressed Air Circuit Breakers are specially designed for the severe repetitive duty of arc furnace operation. They withstand 15,000 operations between inspections. Surge suppressors reduce overvoltages.

*COLOR

For maximum production . . . top efficiency . . . lowest operating cost, give your machines the finest in lubricants—give them Tycol oils and greases.

Tycol lubricants are made to meet every lubrication need of industry—from roll neck greases for steel mills to spindle oils for textile plants.

Each Tycol lubricant is subjected to rigid tests during manufacture. This control assures the required lubrication characteristics—*COLOR, penetration, viscosity, to name a few—for maximum performance of that particular product. At every step from selection of crudes to blending of the finished product, Tycol lubricants provide maximum lubricating efficiency which means greater economy, longer life for every type of equipment.

Tide Water Associated will be glad to assist you in selecting the Tycol lubricant best suited to your specific need. Call or write your nearest office for further details.

TYCOL

INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C. • Pittsburgh • Philadelphia • Chicago Detroit • Tulsa • Cleveland San Francisco • Toronto, Canada

TIDE WATER ASSOCIATED OIL COMPANY

17 BATTERY PLACE · NEW YORK 4, N.Y.

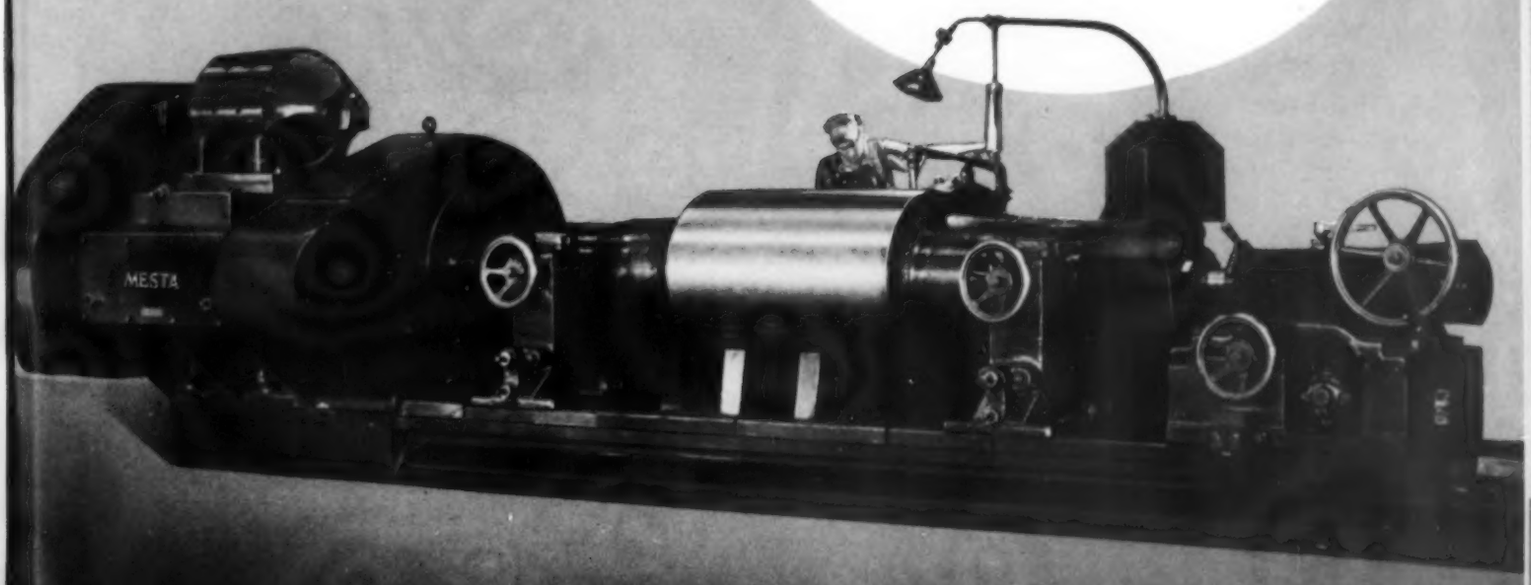
*LEARN WHAT THIS PRODUCT CHARACTERISTIC MEANS TO YOU — READ "LUBRICANIA"
This informative handbook, "Tide Water Associated Lubricania," gives clear, concise descriptions of the basic tests used to determine important properties of oils and greases. For your free copy, write to Tide Water Associated Oil Company, 17 Battery Place, New York 4, N. Y.

REFINERS AND MARKETERS OF VEEDOL — THE WORLD'S MOST FAMOUS MOTOR OIL

MESTA
Heavy Duty
Roll Grinders

Mesta Roll Grinders of simplified design are the most accurate and dependable grinding machines available. Built with precision for finest finishing and ruggedness for heaviest roughing.

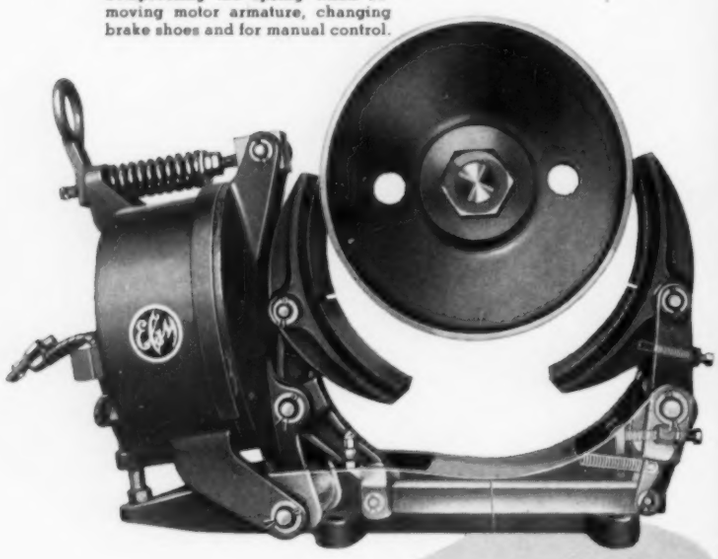
Finishing a 36½"x 56" Mesta Alloy Iron Roll in a Mesta 60" Heavy Duty Roll Grinder.



Designers and Builders of Complete Steel Plants

MESTA MACHINE CO., PITTSBURGH, PA.

Type WB Brake showing how the motor armature is easily lifted out. At top left is the handle-nut for compressing the spring when removing motor armature, changing brake shoes and for manual control.



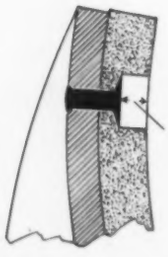
Long Life Brakes for A-C and D-C Motors by EC&M

The brake lining is molded to match curvature of wheel and shoe.

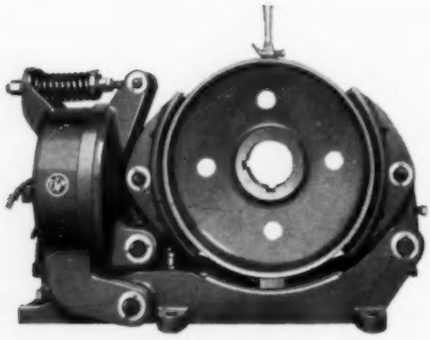
These Type WB Brakes for a.c. and d.c. service have a block type lining which is both thick and tough.

Furthermore, due to the process of manufacture, the blocks have proper frictional quality *throughout the entire thickness* permitting uniform and complete wear down to rivet heads. And since the material is non-compressionable, brake adjustments are infrequent.

EC&M Type WB Brakes are built in several sizes. They can be supplied with series or shunt-wound operating coils for direct current motors. On alternating current service, they are supplied in shunt-wound form for use with a compact rectifier - unit. Send for Bulletins 1004 and 1006 describing these long life brakes.



Actual wearing thickness, between rivet heads and brake wheel, is 1/8" on the smallest size to 1/16" on the largest size.



The BIG No. 60 Type WB Brake. The standard claw-hammer resting on the brake wheel gives a comparison of size.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

THE MORGAN
AIR EJECTOR
gives the draft you want
quickly . . inexpensively

You do not have to invest a fortune in foundations and stacks to exhaust gases from furnaces and boilers, or to discharge acid or other fumes.

It has been proven many times that a Morgan Air Ejector will do the job better and at far less cost.

Write us and let us explain in detail.

CCC-26

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

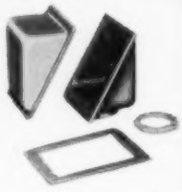
ROLLING MILLS • MORGOIL BEARINGS • WIRE MACHINERY
COMBUSTION CONTROL • PRODUCER GAS MACHINE

HOW IT OPERATES

Cool air is directed upward through the venturi throat, creating a powerful suction in the stack. Superheated gases, fumes, etc., are drawn out without passing through the fan. The gases are mixed with cool air and discharged at low temperature to the atmosphere.

WAGNER MOTORS
...The choice of leaders in industry

IT'S WAGNER *because:*



Moisture-proof and dust-tight cast iron conduit box—screw-on type.

Leads are brought out through threaded nipple and sealed with a flexible compound.

Rugged, corrosion-resistant cast iron frame with inner frame, outer frame and feet cast in one piece.

Wagner Cast Iron Frame Motors

resist the damaging action of acids, fumes, moisture and other destructive elements

Motors used in chemical manufacturing plants, oil fields, coal mines, and in similar applications where corrosion is a problem must be designed to resist damage by acids and alkalies present in the atmosphere in the form of dust, fumes, or moisture.

Wagner cast iron frame motors are built to provide the corrosion-resistance demanded by such applications. They feature well-impregnated, special varnish treated windings protected by totally-enclosed fan-cooled construction . . . a cast iron, gasket sealed conduit box . . . and drain plugs in the endplates for easy removal of any condensation from inside the motor.

These motors are available in ratings from 5 to 250 horsepower, in both standard (type EP) and explosion-proof (type JP) designs.

Bulletins give full information on Wagner Cast Iron Motors and on other motors in Wagner's complete line. Thirty-one branches, located in principal cities, are ready to assist you whenever you have a motor problem.

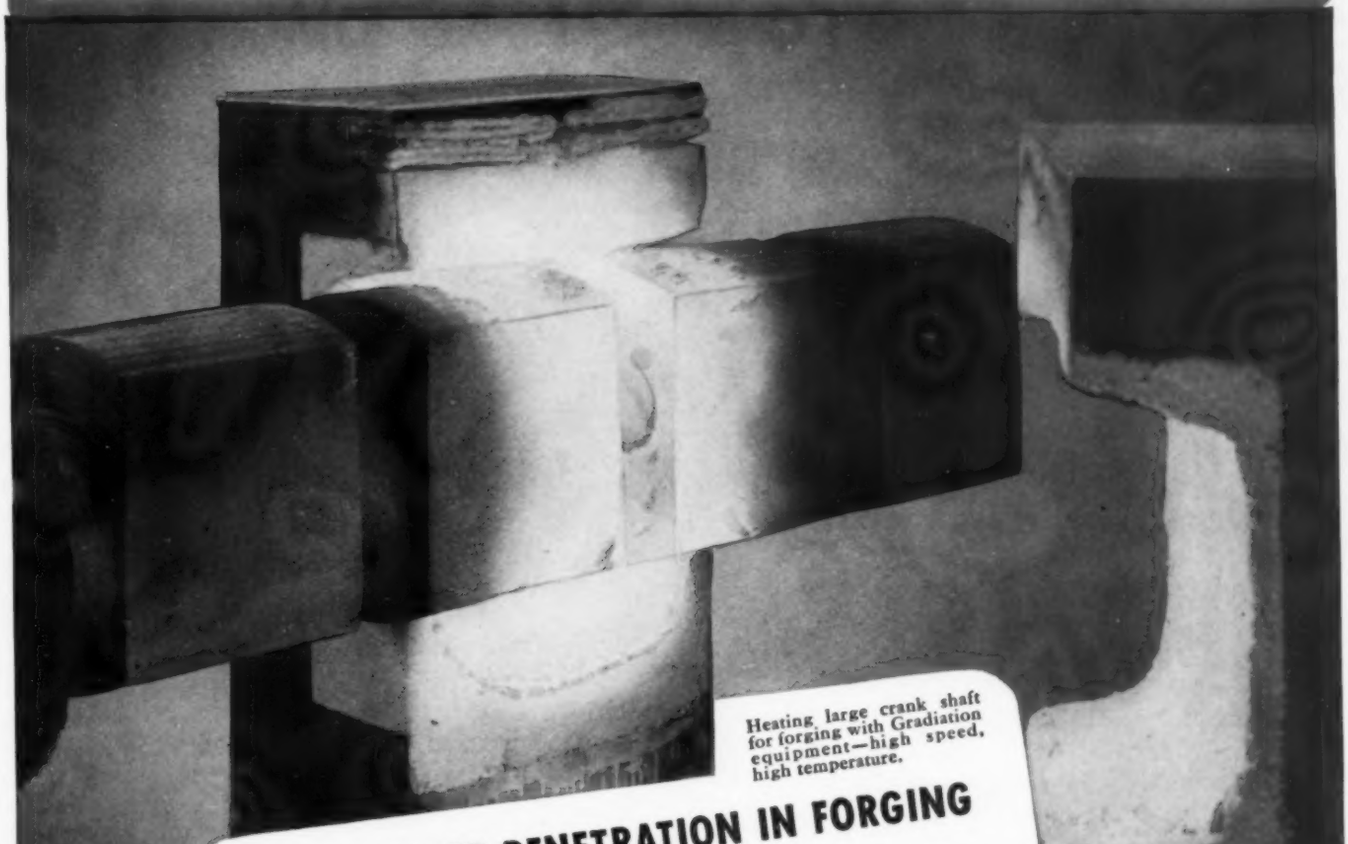
Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

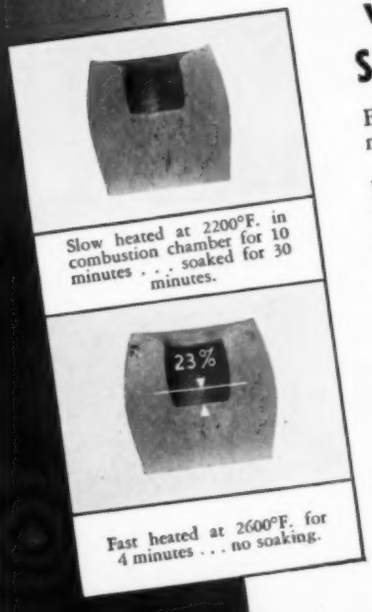
BRANCHES IN 31 PRINCIPAL CITIES

HIGH SPEED HEAT . . . UNIFORM METAL FLOW



Heating large crank shaft for forging with Gradiation equipment—high speed, high temperature.

23% GREATER PENETRATION IN FORGING with SELAS Gradiation



Slow heated at 2200°F. in combustion chamber for 10 minutes . . . soaked for 30 minutes.

Fast heated at 2600°F. for 4 minutes . . . no soaking.

Faster, more uniform heating of metals results in easier metal flow that makes possible deeper penetration.

Selas Gradiation combines radiant gas heat with high heat transfer. High speed . . . high temperature . . . precise control of heat in protective atmosphere. Results have shown heating time is less than 50% of slower methods . . . scale loss is 16% of slow heated steel . . . grain size after fast heating is 10—12% of size after slow heating . . . penetration 23% deeper.

Gradiation makes possible rapid localized heating for forging of larger pieces of metal, faster heating of tubing and billets for sizing, rolling, piercing or forging.

Gradiation puts forging on a production line basis for many products. This has been successfully attained in the automotive industry for the forging of axles and other component parts.

Selas Gradiation has proved the key to faster heat processing and stepped-up production in leading plants throughout the nation. Whatever your heat processing operation, Selas Engineers offer you their experience and manufacturing facilities for improved production.

SELAS CORPORATION OF AMERICA

PHILADELPHIA 34, PENNSYLVANIA

This Tap Changer Story began 20 YEARS ago . . .

Straight Line FACTS

Purchasers of transformers are extremely interested in tap changer design because the failure of a tap changer can cause the failure of a transformer.

Twenty years ago Pennsylvaina Transformer Company developed the Straight-Line Tap Changer and began using it in all Power Transformers. Succeeding years brought modifications and improvements but, in essence, the present Straight-Line Tap Changer is the same as the one introduced in 1930.

For twenty years the Straight-Line Tap Changer has functioned in all types of Power Transformers under all operating conditions.

Not once in all this time has there been any reason to question the fundamental principles of the Straight-Line design.

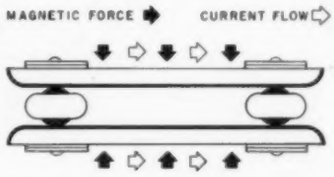
The performance record of the Straight-Line Tap Changer is adding to the reputation of Pennsylvania Transformers. It is one of the reasons for the confidence put in Pennsylvania by a growing number of leading Utilities that are placing important orders for Pennsylvania Transformers.

1. Flexible steel spring construction and straight line motion of movable jaw assures a self-aligning, high pressure contact at all times.

2. All contacts made of a time-tested silver-nickel mixture which possesses the electrical qualities of silver but is inert to chemical reactions. Contacts are pressure and temperature treated for high conductivity and high resistance to wear.

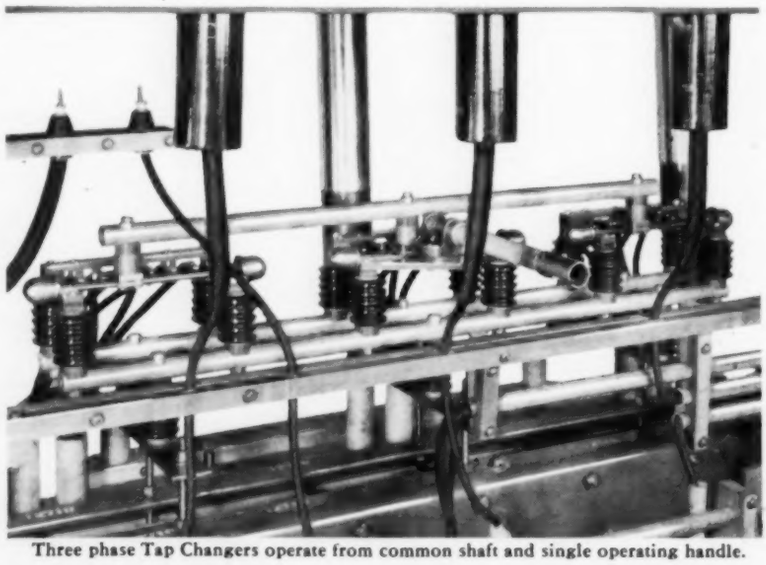
3. Contacts are self-cleaning. Each operation of tap changer results in a positive wiping action.

4. Straight Line Tap Changer withstands dead short circuits. Design of Tap Changer is such that magnetic forces cause moving contacts to increase pressure during short circuits. There is no blow-off action.



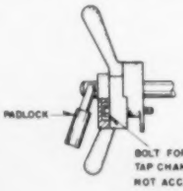
5. Transformer cable leads crimped to ends of stationary jaws. Crimping provides a high quality mechanical and electrical connection without possibility of crystallization due to brazing.

6. Tap Changer located in top section of tank — above core and coils — where it is accessible through handholes or manholes for simplified inspection and maintenance.



Three phase Tap Changers operate from common shaft and single operating handle.

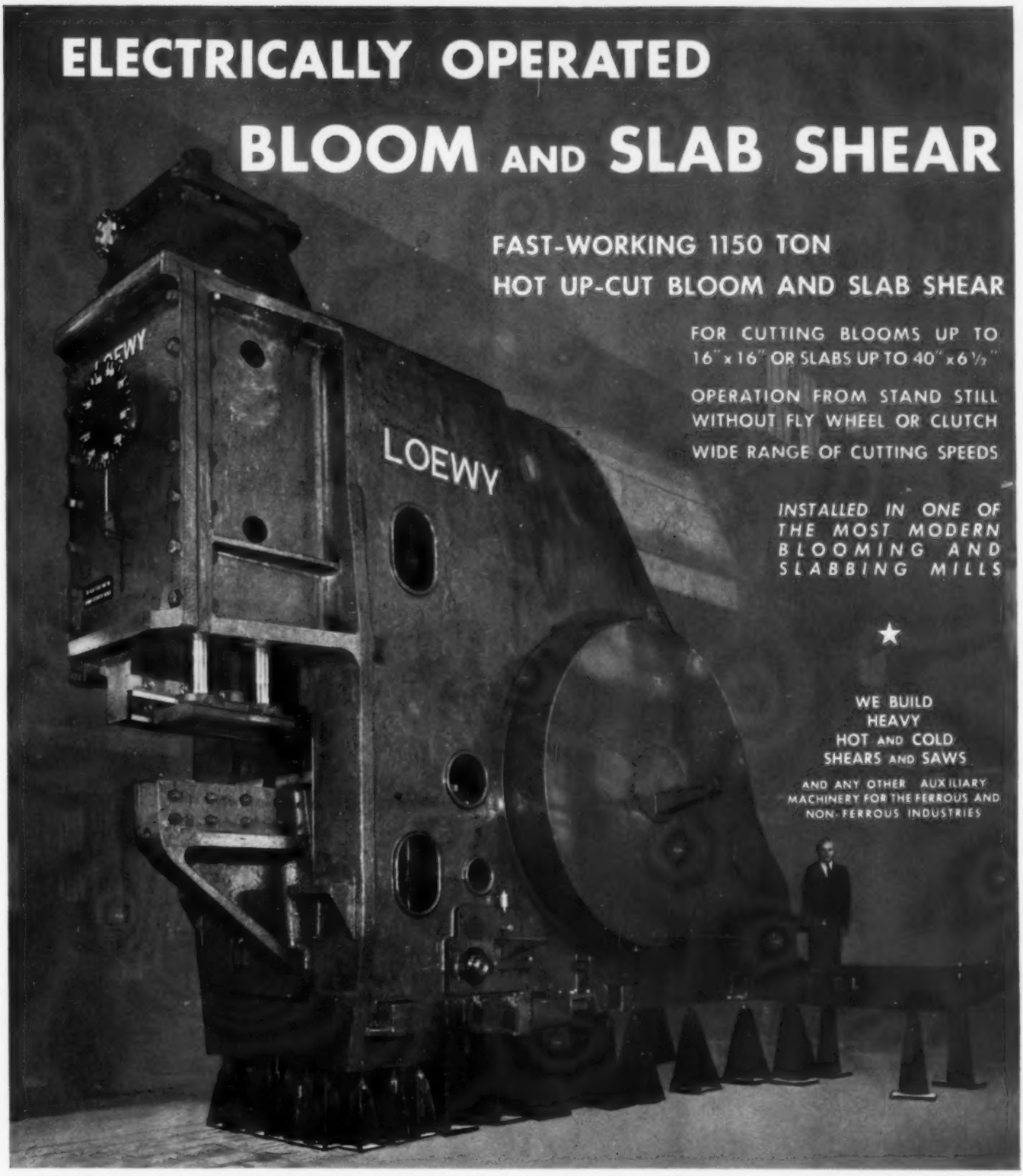
Operating handle issues through side of case and is provided with a positive locking mechanism.



Pennsylvania TRANSFORMER COMPANY

CANONSBURG, PENNA. • Greater Pittsburgh District

ELECTRICALLY OPERATED
BLOOM AND SLAB SHEAR



FAST-WORKING 1150 TON
HOT UP-CUT BLOOM AND SLAB SHEAR

FOR CUTTING BLOOMS UP TO
16" x 16" OR SLABS UP TO 40" x 6 ½"

OPERATION FROM STAND STILL
WITHOUT FLY WHEEL OR CLUTCH

WIDE RANGE OF CUTTING SPEEDS

INSTALLED IN ONE OF THE MOST MODERN BLOOMING AND SLABBING MILLS

★

WE BUILD
HEAVY
HOT AND COLD
SHEARS AND SAWS

AND ANY OTHER AUXILIARY MACHINERY FOR THE FERROUS AND NON-FERROUS INDUSTRIES

HYDROPRESS · INC ·

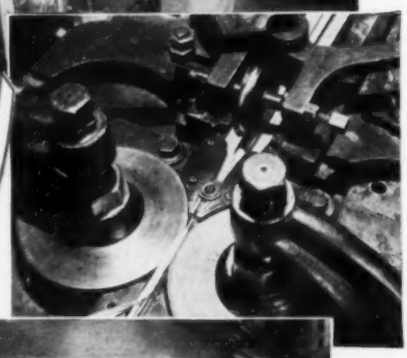
ENGINEERS *CONTRACTORS*

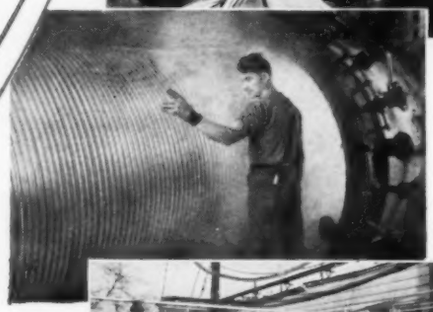
HYDRAULIC PRESSES · ACCUMULATORS · PUMPS
ROLLING MILLS
DIE CASTING MACHINES

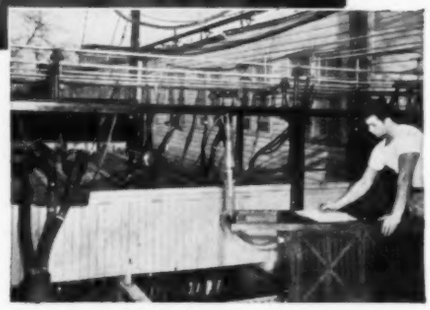
566-568 LEXINGTON AVE. GENERAL ELECTRIC BUILDING AT 51st STREET NEW YORK 22

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.

Its Long LIFE







is an OPEN BOOK...

It's no secret why Okonite cable has a longer life than ordinary cable. The reason lies in rigid adherence to a program of *constant research,* the use of *proved materials* processed with *expert workmanship* and *modern manufacturing techniques.*

Okonite materials are different from, and superior to, those used in conventional cables. For example, Okonite insulation is made only with Up-River Fine Para rubber—the highest quality, longest-lasting, most uniform natural rubber available.

Okonite methods overlook no detail. For example, copper conductors are triple-cleaned: physically, chemically and electrolytically. They are coated not with tin, but with Okoloy, a corrosion-resisting lead alloy. All rubber for the insulation is washed and air-dried. Insulation and Okoprene sheath are applied simultaneously by the exclusive strip process and vulcanized *only once* . . . in a metal mold. This assures perfectly centered conductors, more stable and longer-lived insulation and sheath.

Such scrupulous attention to vital cable manufacturing steps characterizes every part of the Okonite process. Because of this, Okonite confidently subjects every finished cable not only to high voltage a-c tests, but also to self-imposed super-voltage d-c tests in excess of those used by any other manufacturer.

The life of an Okonite cable is an open book. We would like you to see for yourself the materials and methods that add years of life to Okonite cable. You can make arrangements for a plant visit through any of our district offices or simply write to The Okonite Company, Passaic, N. J.

OKONITE

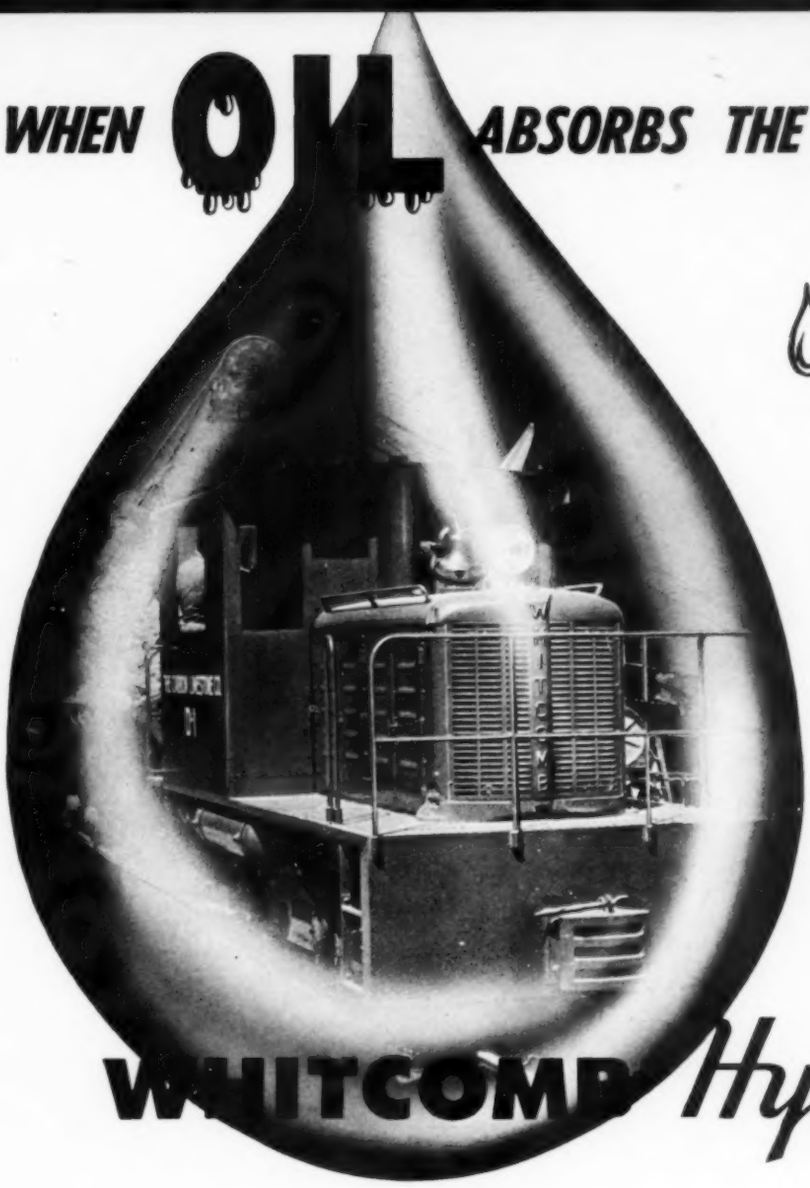
OKONITE SINCE 1878

THE BEST CABLE IS YOUR BEST POLICY

insulated wires and cables

8628

WHEN OIL ABSORBS THE SHOCK



- MAINTENANCE IS LOWER
- LOCOMOTIVE LIFE IS LONGER
- OPERATION IS EASIER
- HANDLING IS SURER, SMOOTHER

WHITCOMB Hydro Motive

You get the smooth, uniform power of an electric drive, at far less cost, with a Whitcomb Hydro-Motive Locomotive. And maintenance costs are lower too. The Whitcomb hydraulic drive means less engine wear because road bed shocks are absorbed in the fluid Hydro-Motive coupling. There is even less "wear" on your locomotive operators, and greater safety too. There is no shifting, no jerking starts. Whitcomb Hydro-Motive power is smooth, instant, uniform power at any speed.

Whitcomb Hydro-Motives are available in capacities up to 25 tons, custom-built to meet your specific needs. They are part of a complete line of finer Whitcomb Locomotives — Diesel mechanicals up to 10 tons, Diesel electrics up to 95 tons, Diesel hydraulics from 10 to 40 tons.

Write today for literature and recommendations on a Whitcomb Locomotive to meet your needs. Throughout industry you will find Whitcomb Locomotives the leading choice of leading firms.

Whitcomb 25-Ton Diesel Hydro-Motive Locomotive hauls 180-ton train at Carbon Limestone Co., Hillsville, Penna.

At Crucible Steel Company of America Whitcomb 25-Ton Diesel Hydro-Motive Locomotive handles train of hot metal ladles at the open hearth.

There is no power more economical than Diesel; no Diesel locomotive finer than a Whitcomb.

BLW THE BALDWIN GROUP

THE WHITCOMB LOCOMOTIVE CO.

ROCHELLE, ILLINOIS

Subsidiary of

THE BALDWIN LOCOMOTIVE WORKS

IT'S HERE!

...THE "CARRIER" STEEL MEN ASK FOR!

ROSS Series 100

NOW STEEL MILLS CAN TAKE ADVANTAGE OF STRADDLE CARRIER MATERIALS-HANDLING . . . SMASH BOTTLE NECKS INHERENT IN ORDINARY METHODS!

Ross Series 100 . . . The *Only* Straddle Carrier Designed and Built for Rough, Tough Steel Mill Service!

It's Rugged, It's Tough . . . Has That Great Reserve Strength Steel men Want!

It's Self-Loading, Unloading . . . Only a Driver Needed!

45,000 Lb. Payloads, 33 MPH Forward or Reverse!

Don't overlook the outstanding advantages of the *simplest mass handling method known!* Get full details on Ross Series 100 Carrier. A 'phone call, wire or letter will do it!

Rely On ROSS

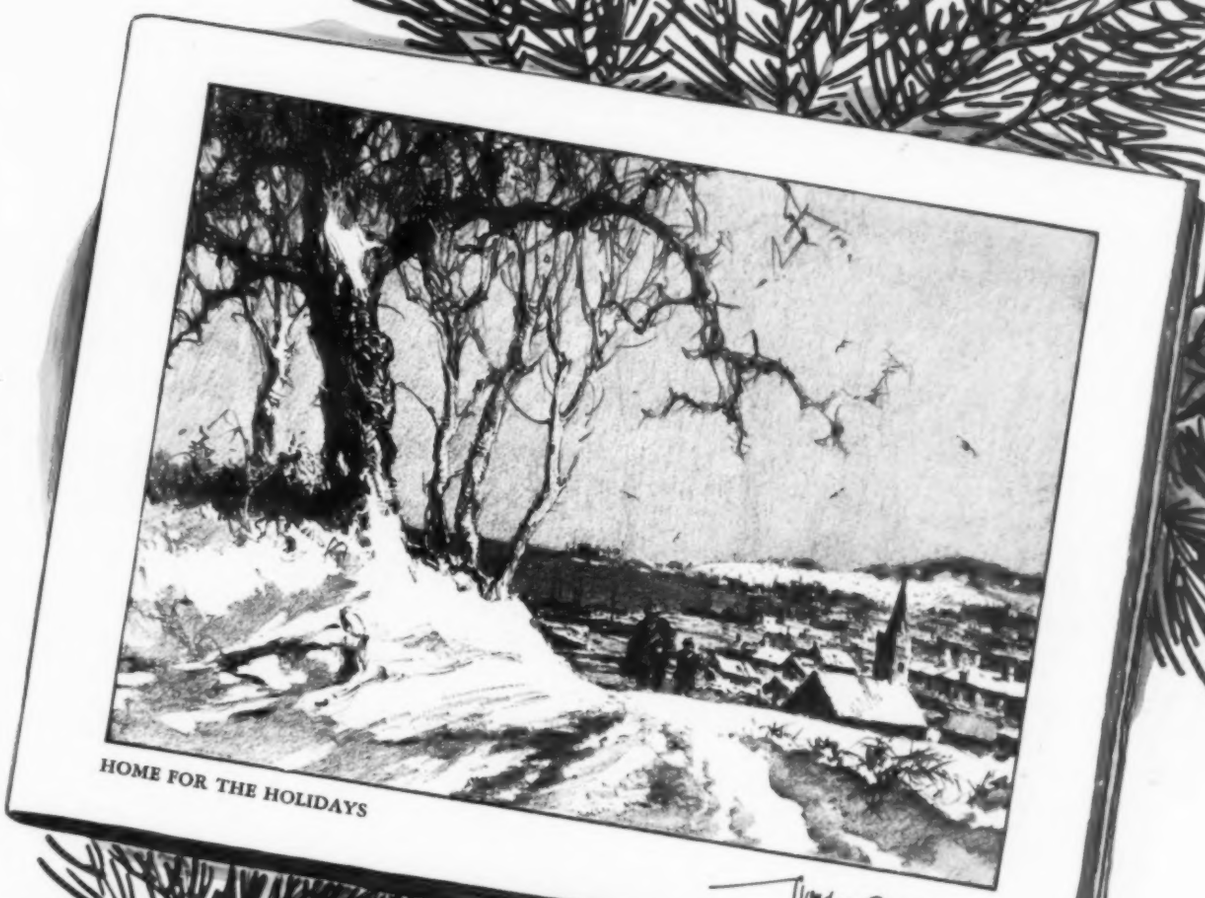
THE ROSS CARRIER COMPANY
400 Miller Street
BENTON HARBOR, MICHIGAN, U. S. A.

LOOK AT THESE ADVANTAGES OF CARRIER HANDLING!

Simplest known method for moving billets, bars, in process and finished materials . . . *where* needed *when* needed, at a moment's notice.

Frees steel mills from restrictions of plant railroad handling systems. Eliminates need for expensive trackage, cars, locomotives . . . costly, time-consuming switching operations.

Prevents congestion in the mill . . . eliminates costly re-handling . . . saves time and money in getting out current orders . . . frees more mill space for production operations.



HOME FOR THE HOLIDAYS

Season's Greetings

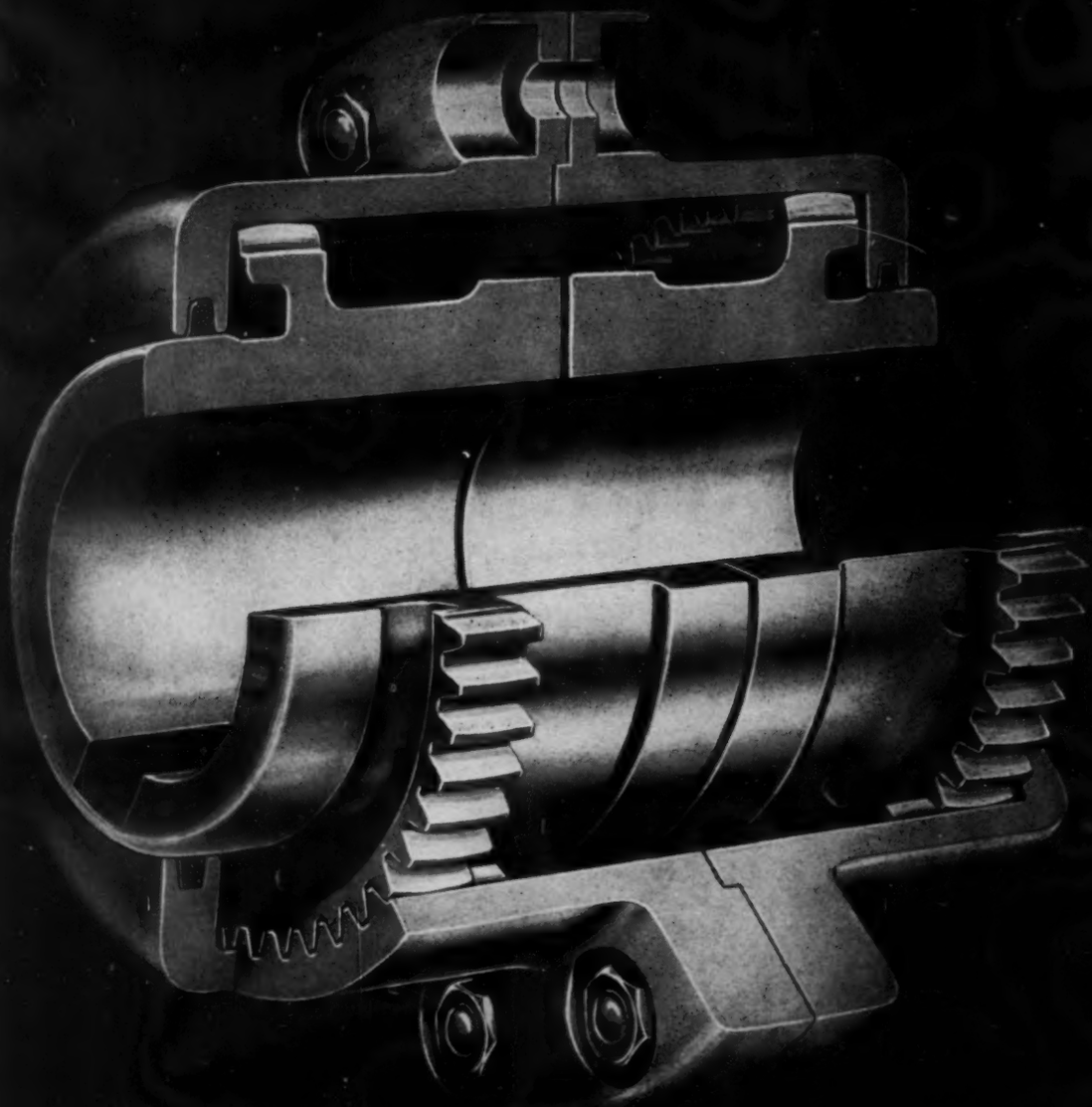
AND BEST WISHES FOR

the New Year

UNITED ENGINEERING & FOUNDRY COMPANY

PITTSBURGH, PA.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

LESS LAG WITH MORE SLAG
. . . cinder car on TIMKEN® bearings

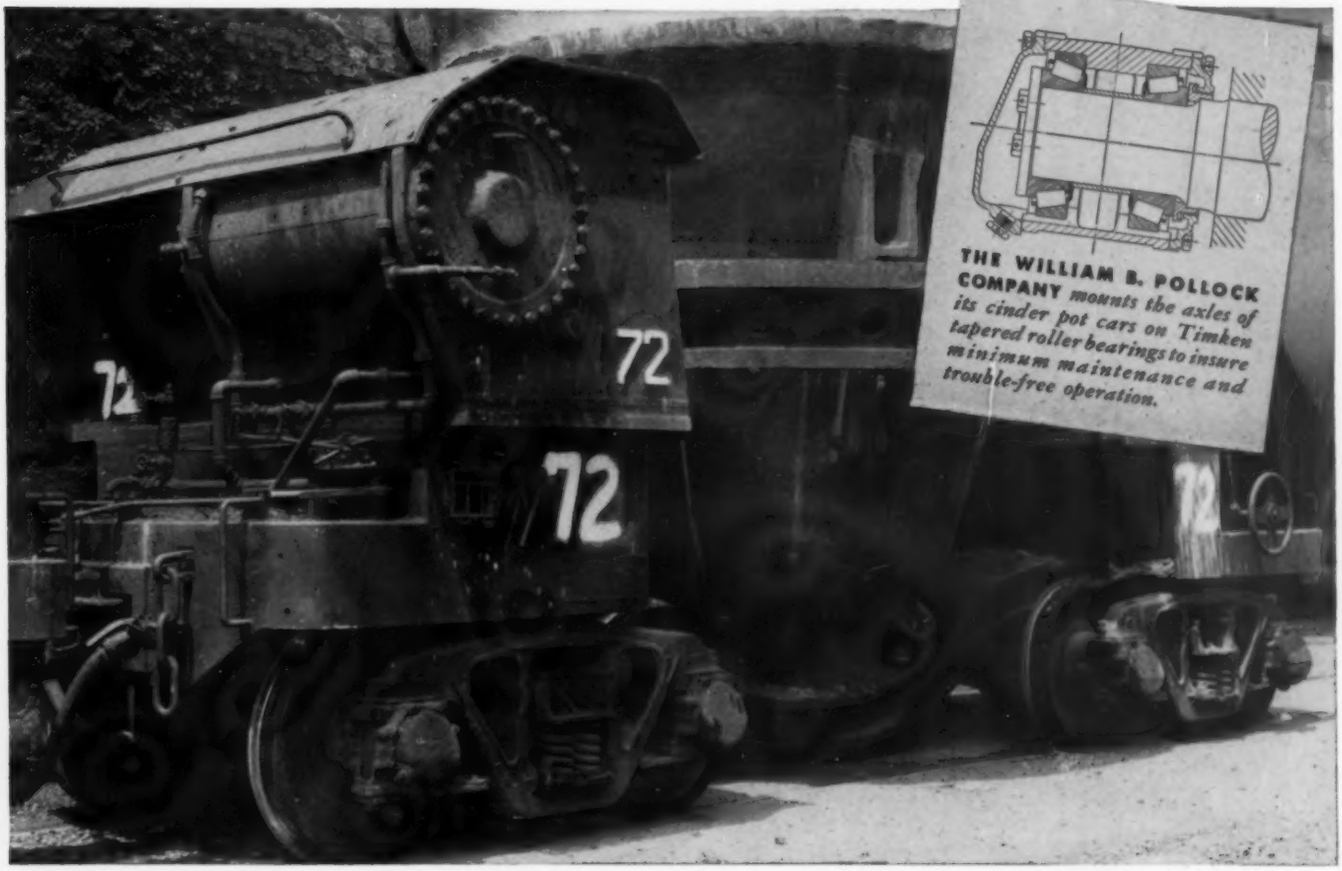
THIS William B. Pollock Cinder Car, in use at one of America's large steel plants, is always ready to go. Equipped with Timken® tapered roller bearings, it starts faster and rolls easier. What's more, it shuttles 400 cu. ft. loads of slag to the slag heap day after day with a minimum of maintenance and lubrication.

Timken bearings in the journal boxes reduce starting resistance 88% of that of friction bearings. Less hauling power is needed. Line contact between rollers and races gives Timken bearings tremendous load-carrying capacity. Tapered design enables them to carry any combination of radial and thrust loads. And with case-hardened surfaces and tough inner-cores, rollers and races resist wear and can take heavy shock loads. With Timken bearings on the job, the problems of belled-out hubs, worn axles, and worn-out thrust washers no longer need worry mill operators.

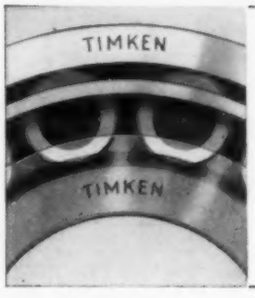
Under normal usage, Timken bearings last the life of the car because they are (1) precisely engineered for the job, (2) made of Timken fine alloy steel, and (3) precision manufactured.

No other bearings can give you all the advantages you get with Timken bearings. Be sure they're used in the machines you buy. And always look for the trade-mark "Timken" on the bearings you use. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



THE WILLIAM B. POLLOCK COMPANY *mounts the axles of its cinder pot cars on Timken tapered roller bearings to insure minimum maintenance and trouble-free operation.*



POSITIVE ROLLER ALIGNMENT

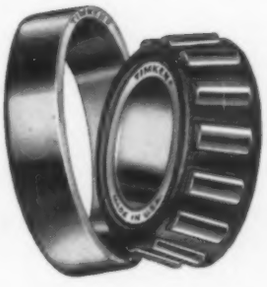
Wide area contact between roll ends and rib of the cone prevents Timken rollers from skewing. Result: bearings roll easier, last longer.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↕ AND THRUST →◎← LOADS OR ANY COMBINATION →✳←

one of many jobs Alliance cranes do so well

● Today's feverish expansion and addition of labor and time-saving machinery calls for a supplier on which heavy industry has depended in the past, a supplier with preknowledge of industry's needs. And because of continuous dependence on **Alliance's** engineering "know-how," producers now are saving time and dollars with equipment that handles ponderous loads accurately with easy finger-tip control. Packed with advanced, smooth, super-efficient movement, **Alliance** cranes show time and dollar savings that reflect profitably in cost accountants' reports.

Alliance cranes have been serving heavy industry since the turn of the century, maintaining smooth-flowing schedules around the clock, year in, year out. When it's economical lifting power you want, let **Alliance — world's largest builder of the world's largest cranes** — develop equipment that is dollar and time suited to your company's operations.

THE ALLIANCE MACHINE COMPANY

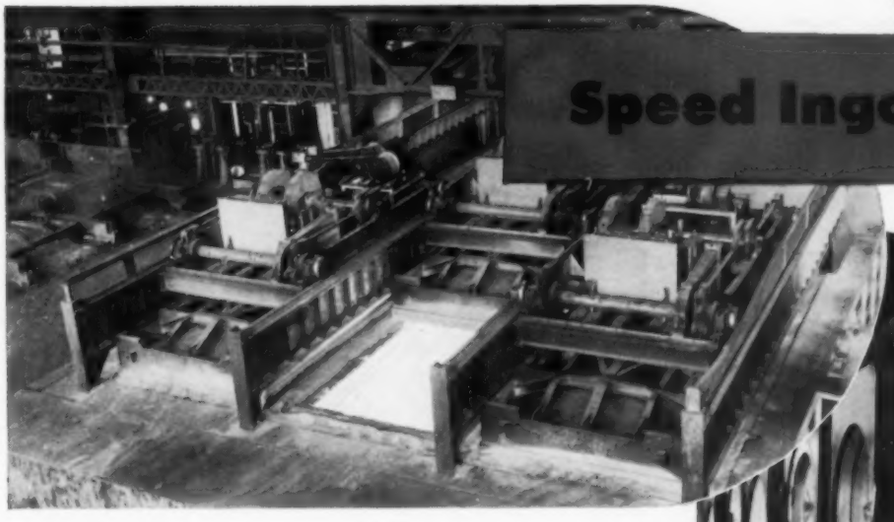
MAIN OFFICE
ALLIANCE, OHIO • PITTSBURGH OFFICE **1622 OLIVER BUILDING, PITTSBURGH, PA.**

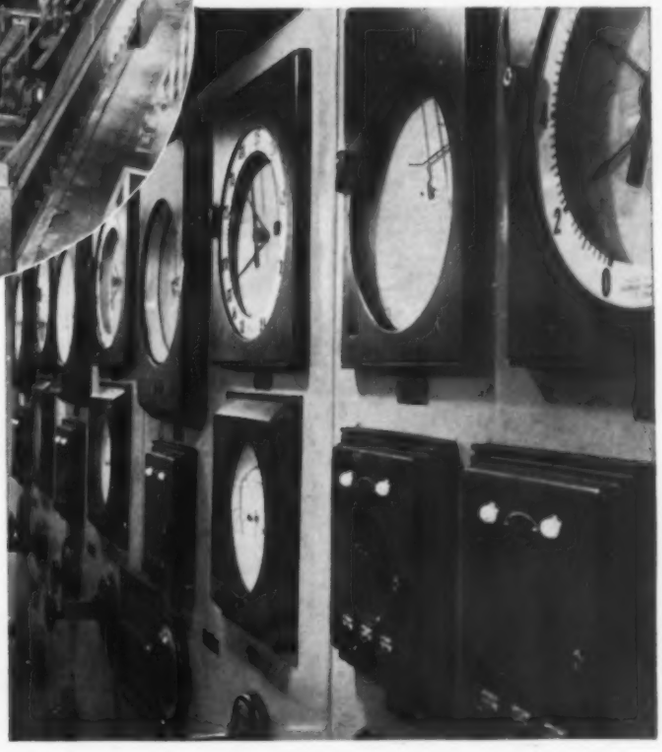
LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

Improve Your Soaking Pit Techniques—

and

Speed Ingot Production





WITH

ElectroniK

CONTROL SYSTEMS

SOAKING PIT operations have advanced materially. From a single panel board, temperature, flow and pressure are instantly and automatically controlled . . . resulting in faster heating rates with lower scale losses.

The system is simple and dependable. Featuring *ElectroniK* (electric or pneumatic) proportional controllers with automatic reset . . . utilizing fast and sensitive *Radiamatic* units . . . the system also includes Brown flow meters and furnace pressure controllers.

Outstanding advantages of the system are:

- *Speed heating of both cold banked and short track time ingots.*
- *Wide turndown on fuel input provides soaking operations without increasing ingot temperature.*
- *Temperature control valve operated by cover removal assuring immediate and automatic fuel cut-off . . . and rapid temperature regain after cover replacement.*
- *Automatic program control or adjustable maximum fuel rates for heating alloy ingots.*

This coordinated instrumentation . . . designed for improved soaking pit techniques . . . will be the plus-factor in your search for greater and more efficient production. Call your local Honeywell engineer for detailed information . . . he is as near as your phone!

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

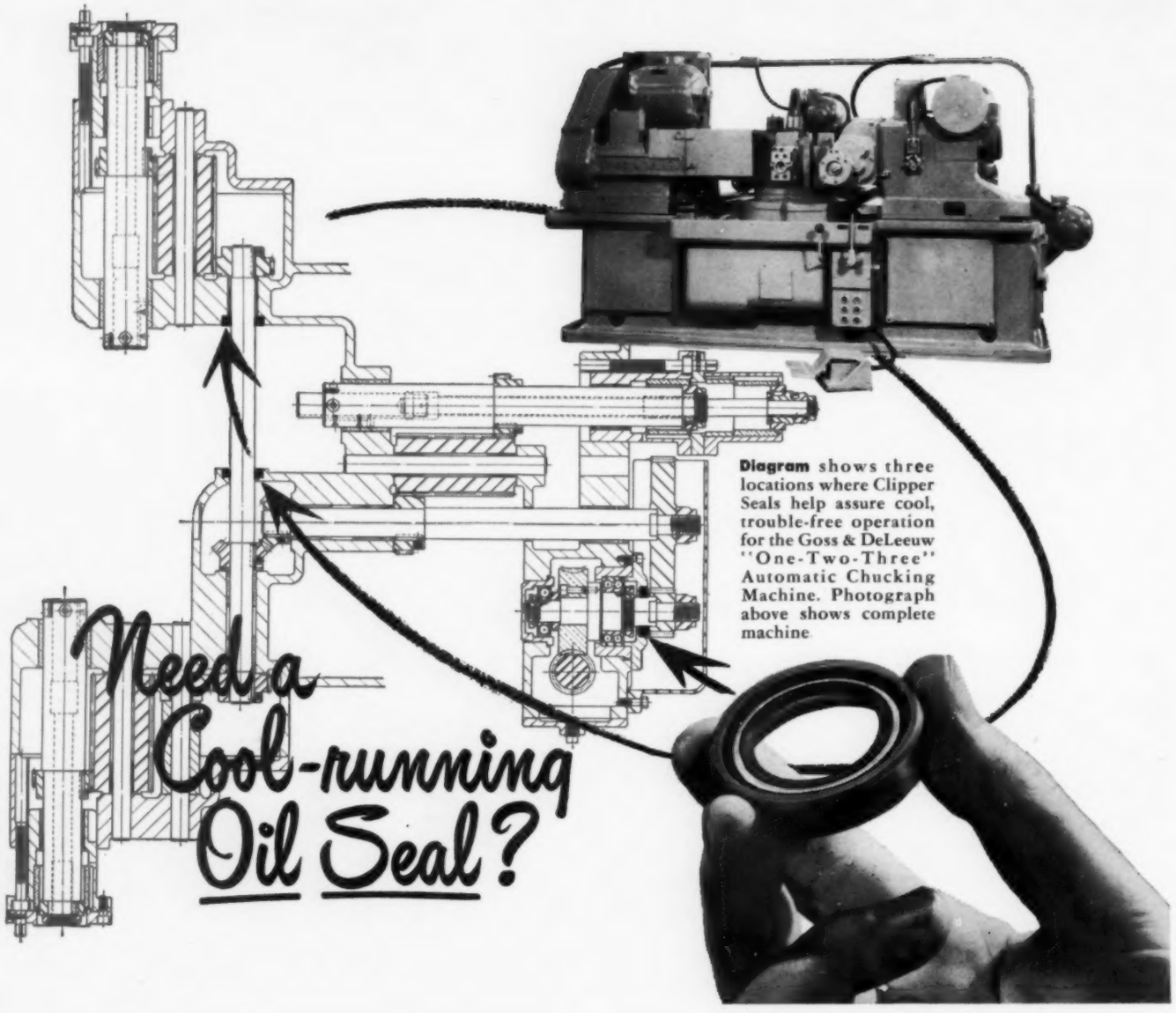


Diagram shows three locations where Clipper Seals help assure cool, trouble-free operation for the Goss & DeLeeuw "One-Two-Three" Automatic Chucking Machine. Photograph above shows complete machine

Need a Cool-running Oil Seal?

Goss & DeLeeuw turns to Clipper Seals

IF YOU'RE SEARCHING for an oil seal that you can depend on to run cool . . . thereby minimize friction and shaft wear, and last longer . . . you'll be interested in hearing why The Goss & DeLeeuw Machine Company selected Clipper Seals for their "One-Two-Three" Automatic Chucking Machine.

The "One-Two-Three"—a revolutionary contribution to the metal working field which permits machining three-faced parts in a single operation—required an oil seal that would minimize friction and wear at high shaft speeds. It would also have to do a highly efficient job of keeping lubricants in place.

After careful tests, Goss & DeLeeuw found that the simple design of the Clipper Seal decidedly reduces friction and wear . . . assuring cool, trouble-free operation plus a long service life. They found, too, that Clipper Seal's tough, dense heel gives the rigidity necessary for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, provides effective sealing at all times.

The solution to *your* sealing problem may be this all-round efficiency of Clipper Seals. They come in a variety of precision-moulded designs . . . in sizes to fit shaft diameters from ¼" to 66", for temperatures to 450F, and for shaft speeds to 3500 rpm. Get complete information by writing for Brochure PK-46A. Address Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

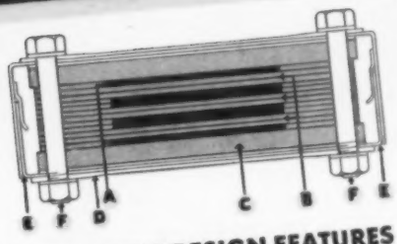
DESIGN LEADERSHIP IN THIS NEW *Weatherproof* FEED-IN DUCT

UNDERWRITERS LABORATORY APPROVED ***for Weatherproof Installations—Either Horizontal or Vertical Riser Runs.*** In addition to its complete steel enclosure, this new Weatherproof Duct has all the basic important internal design features of Square D's standard line of Feed-in Duct.

INCREASED EFFICIENCY. Temperature rise 50% lower than for other totally enclosed busses of equal copper cross-section and rating. Balanced voltage drop of only 1.8 volts per 100 feet.

MINIMUM SIZE. Exclusive design requires no ventilating openings for limiting temperature rise. Permits compact, rigid structure with high resistance to heavy electrical stresses.

EASILY INSTALLED and MAINTAINED. Standardized straight sections and fittings. See panel at right.



EXCLUSIVE DESIGN FEATURES

"One-split" bus **A** with halves positioned on either side of other two busses, permits close spacing and electrical symmetry important to reduction of both energy loss and voltage drop.

Solid ebonized asbestos insulating plates **B** and **C** which totally enclose bus, have great mechanical and high dielectric strength, conduct heat readily, are impervious to moisture and resistant to arc.

Surge clamps **D** and bolts **F** every 24" give structural and mechanical strength necessary to withstand 50,000 ampere shorts.

Steel housing **E** completes the weatherproof enclosure.

Write ***for Bulletin 5600. Address Square D Company, 6060 Rivard Street, Detroit 11, Michigan.***

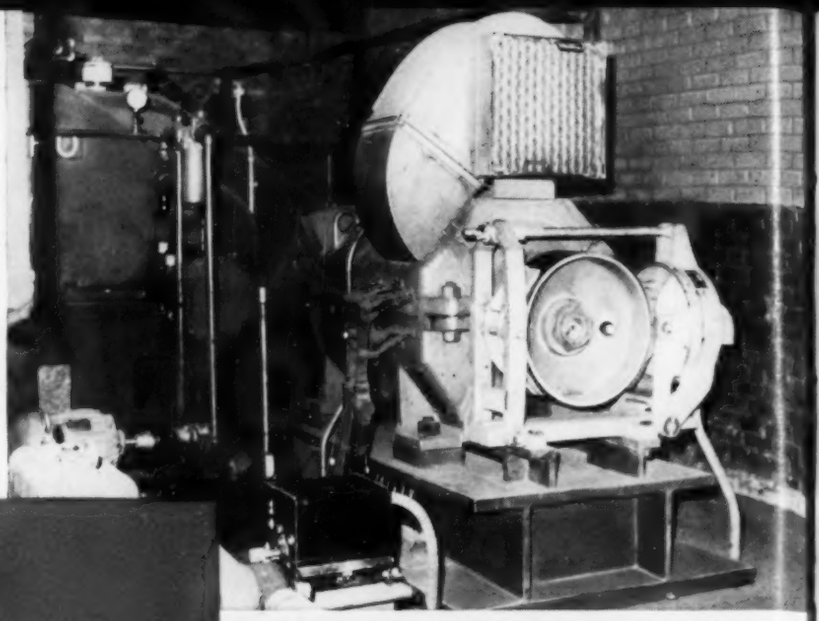
SQUARE D COMPANY

DETROIT · MILWAUKEE · LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

The MILL MOTORS you wanted . . .

now setting new efficiency records on the industry's toughest drives

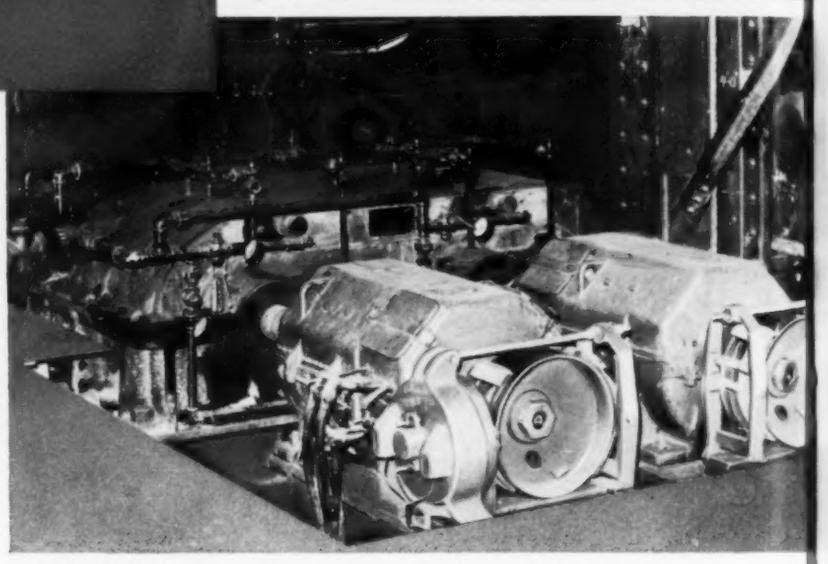


ELLIOTT
CROCKER-WHEELER
W600 Series

The new Crocker-Wheeler W600 Mill Motors conform in all respects to current AISE standards. They are the motors you asked for, and now their ability to take the heavy overloads and severe reversing strains of today's most punishing mill service has been proved in many applications.

They give you more power without increase in frame size, better cooling, better commutation. By every test, they are your logical choice for all replacements, for all new drives.

Available in ratings from 5 to 265 hp . . . in AISE frames 2W5 to W-618 . . . totally enclosed, protected self-ventilated, or separately force-ventilated.



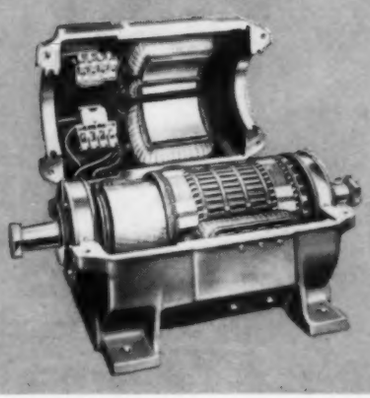
AT ROTARY ELECTRIC STEEL COMPANY, Mound Road Plant, Detroit, these Elliott C-W W600 Mill Motors have been in service for over a year. Above, two 250-hp, 420/480-rpm separately excited, force-ventilated, shunt wound W600 motors drive the up-cut shear. Below, two W600 motors are shown on the manipulator. Four similar motors are on front and back work tables. Many other W600 motors are used throughout the plant.

MORE EFFICIENT . . . BY DESIGN

MORE POWER—SAME DIMENSIONS The new C-W 7½-hp Mill Motor, for example, has the same dimensions as the former 5-hp Mill Motor.

MORE EFFECTIVE COOLING Despite increased power per frame, motors stay within established temperature limits because improved, directed internal air circulation insures better heat transfer to frame for dissipation.

IMPROVED INSULATION New insulating materials in armature and field coils assure lasting resistance to high temperatures, moisture, and oil.



BETTER COMMUTATING CAPACITY Improved design assures proper commutation under extreme service. Tests up to 300 per cent current show negligible sparking.

GREATER SHAFT STRENGTH Although now required to transmit about 50 per cent more torque, maximum shaft stresses are not increased over previous AISE standardized Mill Motors.

TIME-SAVING ACCESSIBILITY Rugged cast steel split frame is hinged (except in 3 largest sizes), permits ready access to all motor parts. This, together with other internal design improvements, facilitates handling and avoids possible damage.

CW-15

NEW BULLETIN SL-620-1A, free on request, describes the many exclusive construction features of the W600 Series. Write: Advertising Department, Elliott Company, Jeanette, Pa.

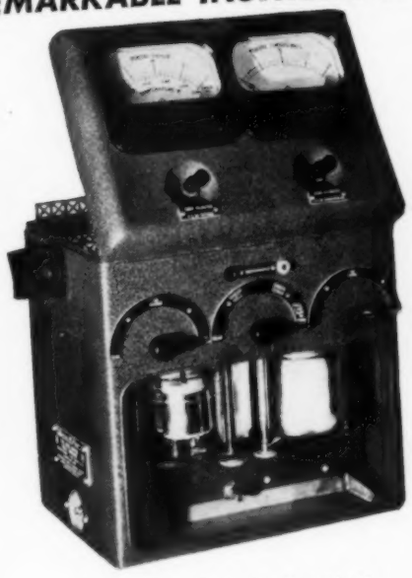
ELLIOTT COMPANY

CROCKER-WHEELER DIVISION

For heavier mill services, Elliott FABRI-STEEL Motors and Generators are available from Ridgway Division of Elliott Company, Ridgway, Pa.

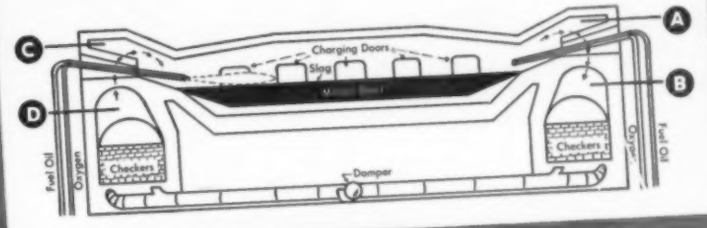
PRODUCTION BOOSTED

BY STRAIGHT ANSWERS FROM THIS REMARKABLE INSTRUMENT



"The way the Cities Service Heat Prover analyzed combustion atmospheres, we knew right off what to correct."
--Open Hearth Operator

Cities Service Heat Prover is applied at A and B—or C and D (on reverse cycle)



This highly developed flue gas analyzer gives correct reports on any type and size of furnace. Quickly, accurately and fully it lets you know how much fuel may be going to waste; whether there are combustibles, or excess oxygen to cause troubles like scaling; what combustion losses are due to useless heating of excess air. Corrections can then be made for added production efficiency. You can profit by this check-up service. Ask about arrangements.

For the Metal Fabricating Industry—
a complete line of petroleum products that includes:

Chillo Cutting Oils	Pacemaker Hydraulic Oils
Trojan Greases	Optimus Cylinder Oils
Trojan Gear Oils	Q-T Quenching & Tempering Oils
Pacemaker Compressor Oils	Pacemaker Turbine Oils

For complete details, mail coupon today and receive your copy of "Combustion Control for Industry."

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QUALITY PETROLEUM PRODUCTS

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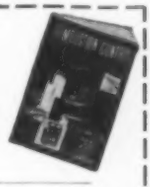
New York 5, New York

Please send me, without obligation, a copy of "Combustion Control for Industry."



Name_____

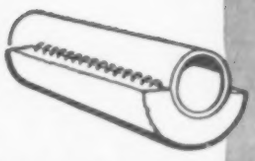
Company_____

Address_____

City_____ State_____

Announcing

BLOOM Ka-Weld



Ka-Weld Precast lower half section is applied, and held in place by welding the exposed ends of the reinforcing wire to the pipe.

PIPE INSULATION
for Underfired Furnaces
precast, reinforced

Here is a simple, practical way of reducing costly heat losses, improving fuel rates and increasing the production of underfired furnaces!

Bloom ***Ka-Weld*** precast, reinforced pipe insulation, applied to water-cooled skid pipes, risers and cross-overs, reduces the heat loss to the cooling water by as much as 82% at 2400° F. furnace temperature. Steel is heated more uniformly top and bottom, skid marks are practically eliminated, there is less slag.

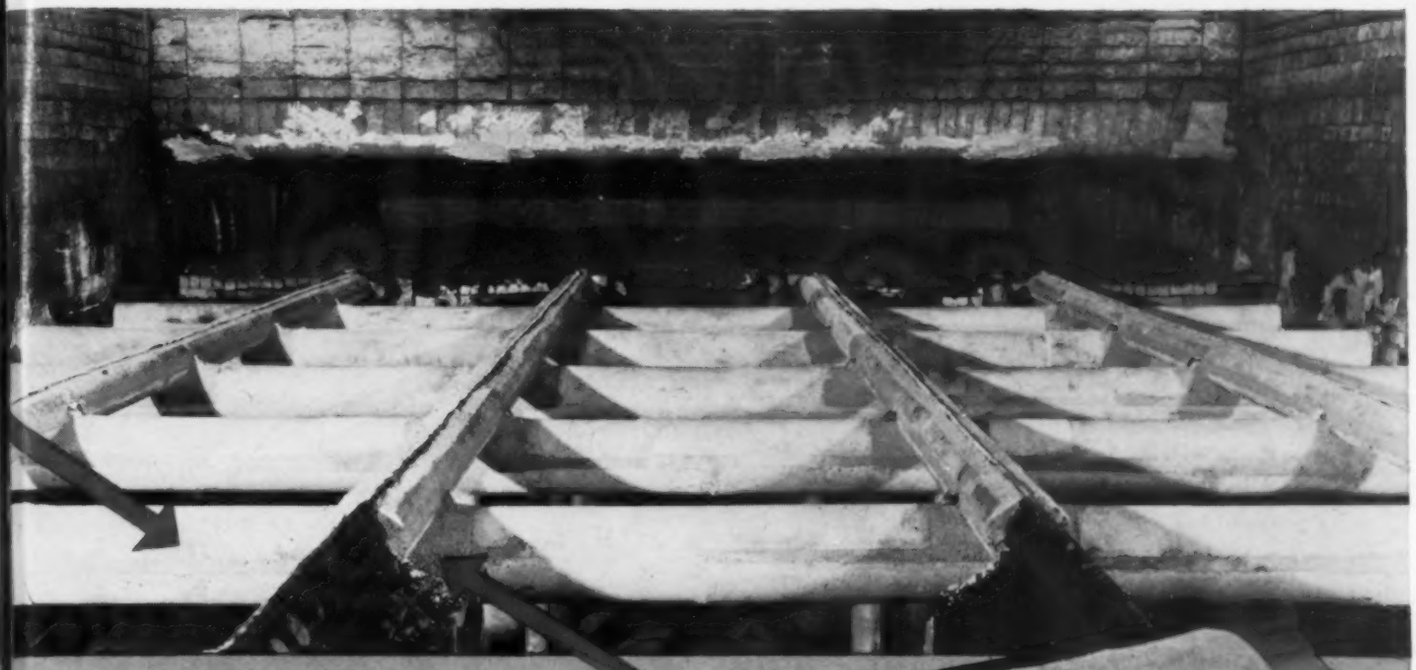
In one furnace, the installation of ***Ka-Weld*** resulted in a saving of 35,000 cu. ft. of natural gas per hour. By thus reducing the demand upon stack, burners and fans, the furnace capacity was increased 20 tons per hour.

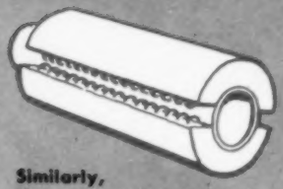
Ka-Weld Insulation is designed and made for long life and continuous service. It consists of high grade refractory material, precast in convenient lengths and reinforced by a mesh of alloy steel. It is easy to install and durable. The illustrations above show how sections are permanently fastened in place by welding the exposed ends of the mesh to the pipes. The normal pipe surface of a 250-300 sq. ft. furnace can be covered in 10 to 14 hours.

The fuel saving and improved quality of steel in furnaces equipped with Bloom ***Ka-Weld*** is immediately apparent, because the fuel rate can be accurately measured and the steel quality readily appraised.

The need for pipe insulation to prevent the great heat loss to cooling water in underfired furnaces has been widely recognized. Bloom ***Ka-Weld*** is an economical, practical solution to the problem.

We will be glad to give you complete details on ***Ka-Weld*** at your convenience.





Similarly, the upper half is applied and welded.

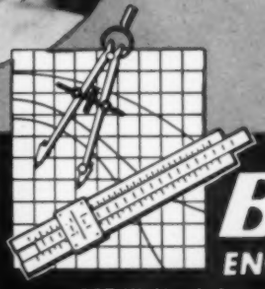
Installation is completed by filling in the space between the two halves with castable refractory.

For skid pipes, the lower half-section is applied as for crossover pipes, and castable refractory applied over alloy steel mesh welded between skid and lower half-section.

These photographs show how Bloom *Ka-Weld* is applied to skid pipes, crossovers and risers of a typical underfired furnace.

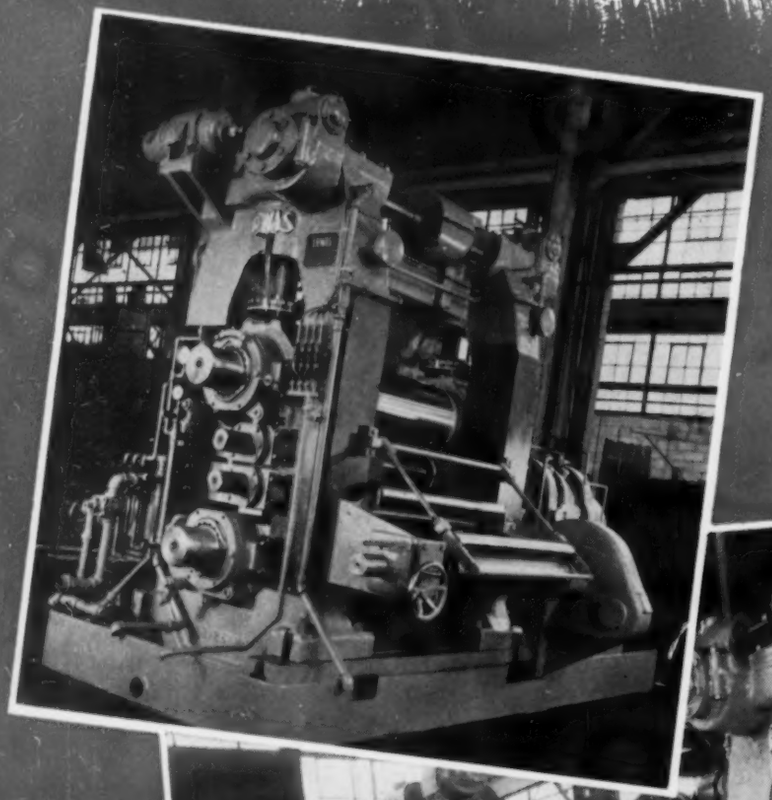
WRITE FOR BULLETIN 2183

This free bulletin gives additional information, curves and illustrations of Bloom *Ka-Weld* Pipe Insulation.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

LEWIS ROLLING

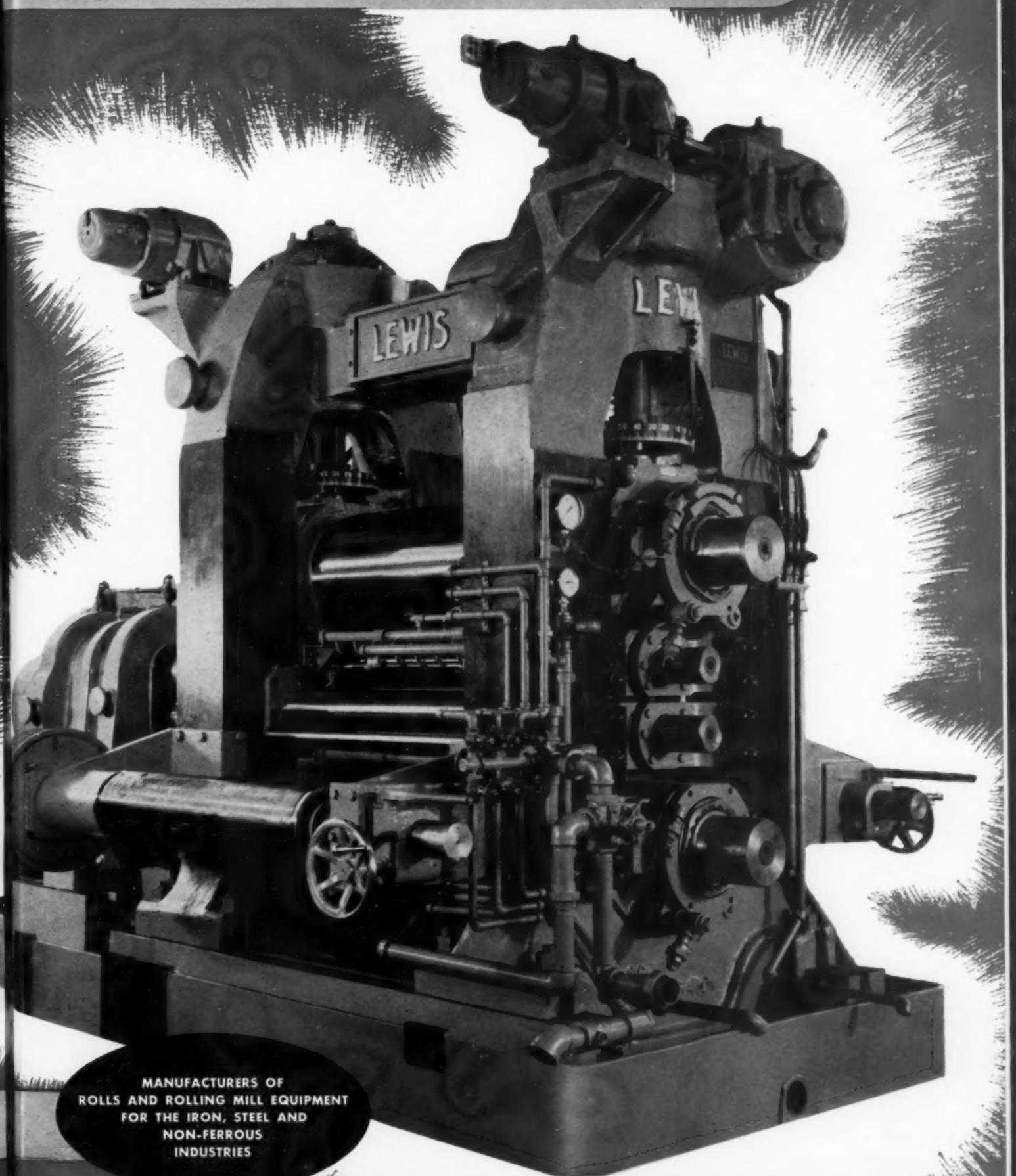


The Lewis 9" and 21" x 44" 4 Hi Mill illustrated maintains maximum production with extreme accuracy of gauge. Equipped with approved type anti-friction bearings and pressure lubrication throughout.

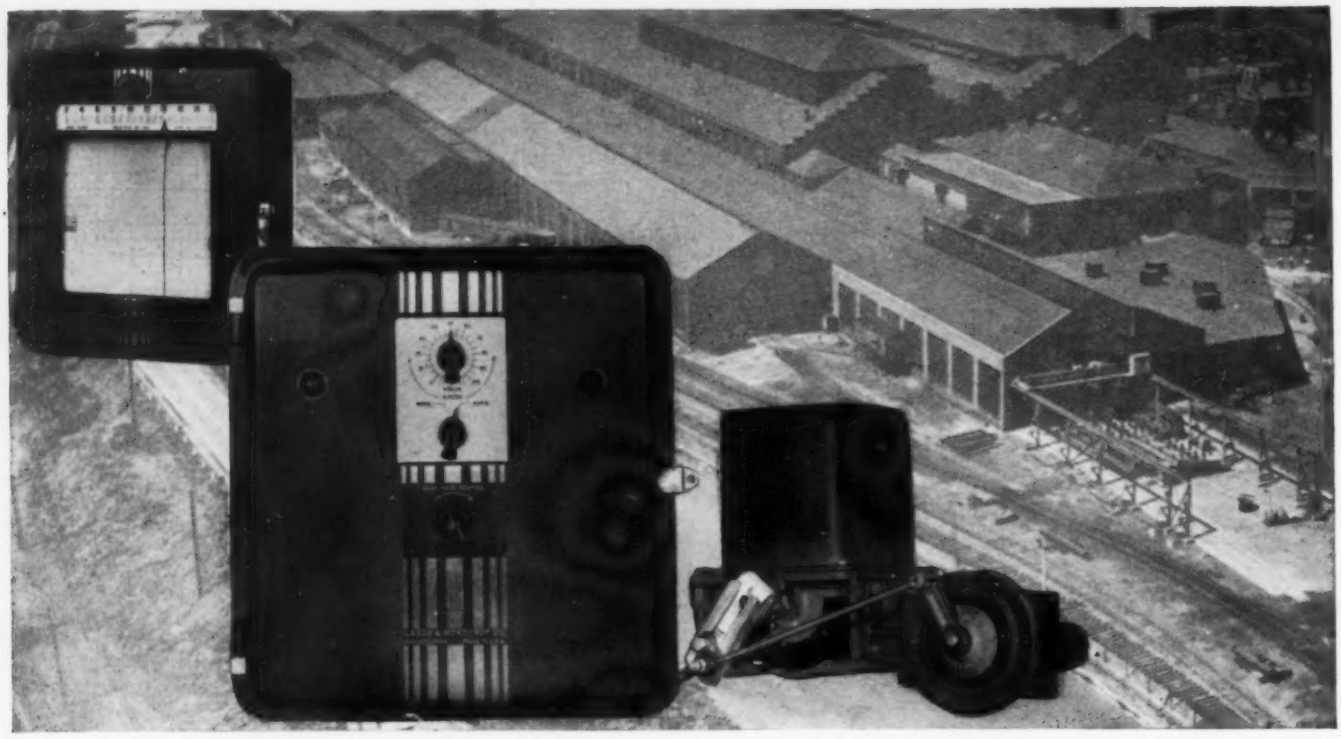
This installation is typical of rolling mill equipment which Lewis furnishes the iron, steel and non-ferrous industries. Inquiries are always welcomed.

LEWIS FOUNDRY & MACHINE *DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.*

MILL EQUIPMENT....



MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES



Major Advance in Electric Control Increases Production From Industrial Operations

With production demands reaching toward fresh all-time highs, this new P.A.T.'50 Control comes at the ideal time to help thousands of firms increase the output of their industrial furnaces. Here's why:

This Control has something that's brand new. It acts on the *speed* of swings in furnace load, as well as on their size and permanence. Thus, if temperature changes gently, it is gently nudged back into line. But if it starts off briskly—as when the furnace door is opened—P.A.T.'50 reacts briskly. The faster the change, the further P.A.T.'50 moves the fuel valve. Then, at the instant this action begins to head off the change, the Control starts backing away. By putting on the brakes it brings temperature back in line smoothly, rapidly.

This "Rate Action" increases production because it reduces the length of time a furnace is off temperature. It means more heats per week.

P.A.T.'50 is the Only electric positioning control with Rate Action. It's a unique L&N contribution to automatic regulation.

Also, Proportioning and Reset Actions are more responsive than before. These two components have always been vital to automatic control, and of course continue so. They stop the normal, every-day temperature swings which are started by changes in the size and permanence of the furnace load.

When we gave P.A.T. its third component of rate action—and introduced it in this '50 model—we were able also to increase the sensitivity and range of adjustment of proportioning and reset components. The resulting improvement in control action shows up at all times, but especially when temperature is being stubborn—trying to edge away from the control point, or to level off incorrectly. Even without rate action, P.A.T.'50 would do a better-than-ever job. But with rate action, results are far superior to any previous electric control.

The News is in the Control Unit. Everything new in P.A.T.'50 is in the Control Unit—the device in center of above illustration which is usually mounted below the Speedomax or Micromax Recording Controller, and which links that instrument to the fuel-valve-driving mechanism. In line with our policy of making improvements readily available to users of our equipment, earlier installations of P.A.T. Control can be converted to P.A.T.'50 by replacing the Unit and making slight changes in the Controller. The new Unit is fully electronic—has no moving parts except two hermetically-sealed relays.

For complete details, contact our nearest office, or write us at 4942 Stenton Ave., Philadelphia 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad ND4-33(1)

Which WHEEL Would You Omit?

Every wheel is important in a watch, obviously. In Steel Mill Lubrication Systems, too, ***all*** four fundamentals of design are vital to the proper functioning of the mill. De Laval engineers assure completely dependable performance at all times because they emphasize each of the following basic requirements:

PURIFICATION OF LUBRICATING OIL

De Laval Oil Purifiers, furnished as part of the design where possible, are permanently piped to the system to permit centrifugal by-pass purification of the lubricant in service. The Purifiers remove water and fine solid contaminants.

PROPER SELECTION OF PIPE SIZE

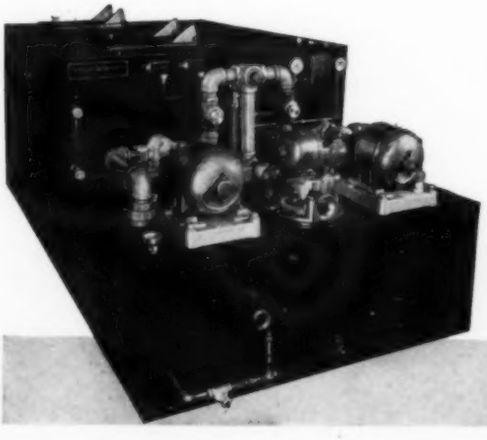
The proper selection of pipe size is important to provide efficient lubrication. All De Laval Systems are designed to keep the pressure drop due to line friction at a minimum, and to insure a streamline flow.

CORRECT METERING OF LUBRICANT

De Laval Systems stress supplying each bearing and gear mesh point with exactly the right amount of lubricant. A constant streamline flow of lubricant in the correct quantity and pressure must be maintained at all times.

EFFICIENT TEMPERATURE CONTROL

De Laval Systems incorporate a constant control of the lubricant temperature both winter and summer. By the use of efficient heating or cooling facilities, a continuous flow of lubricant at the correct temperature and viscosity is maintained.



THE DE LAVAL SEPARATOR COMPANY
165 Broadway, N. Y. 6 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
DE LAVAL PACIFIC COMPANY
61 Beale St., San Francisco 5

DE LAVAL

ENGINEERED SYSTEMS

. . . is a "cinch" for the maintenance crew

FARREL
ROLLING MILL
MACHINERY

Rolls • Rolling Mills • Rod Mill Tables and Manipulating Equipment • Universal Mill Spindles • Rod Coilers • Gears • Mill Pinions • Pinion Stands • Gear Drives of any Capacity • Flexible Couplings • Roll Grinding Machines • Roll Calipers • Lead Presses for Pipe or Rod.

Farrel gear drives and pinion stands are never on the "worry list" of the maintenance department. They transmit power, quietly and efficiently, year in and year out, with a minimum amount of routine attention. They have built-in durability that takes it easy on maintenance time and dollars.

Features which assure trouble-free operation and long life are incorporated in this 2,000 horsepower combination unit. All gears and pinions are precision generated by the famous Farrel-Sykes process. The first reduction gears and the mill pinions are herringbone type, while the second reduction consists of split (divided) double helical gears. This makes a compact arrangement which distributes the load uniformly and requires minimum floor space.

A unit-type pressure lubricating system, with separate motor-driven pump, provides a continuous spray of oil at the mesh line of all gears and pinions and force-feed lubrication to all antifriction bearings. The pinion stand housing is of cast Meehanite metal and the base and cover for the drive are substantial steel weldments.

Designed to suit individual requirements, Farrel rolling mill drives and pinion stands—separate or combination units—are available in any capacity. Farrel engineers will be glad to supply full information for any specific application.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Akron, Pittsburgh, Chicago, Los Angeles, Houston

Farrel-Birmingham®

FB-630

**BILLET-CLEANING FASTER,
BETTER, CHEAPER WITH BILLETEER**

Bonnot Billeteers cut out deep flaws or shallow imperfections with perfect ease, speed and safety. An operator removes a 12″ chip in 2 seconds, as the 45 ton machine responds to his finger-tip control, while it takes a hand chipper 30 times longer to do the same job — and hand chipping is grueling work all the way.

What's more, the Billeteer's unmatched speed does this work for 50-60% less than hand chipping costs. At the same time the Billeteer also eases your personnel problem because men like to operate the safe, simple Bonnot Billeteer. Such operators usually "stay put."

In addition, Billeteer-cleaning is definitely preferred over torch-cleaning in many situations, when measured by costs or quality or both.

Many leading steel producers here and abroad have made the profit-wise decision, and employ Bonnot Billeteers for faster—safer—cheaper—better cleaning.

Why not wire or write for complete information?

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of Sawing • Crushing • Pulverizing and Mixing Equipment • Billet Inspection Tables • Dust Pug Mills • Sinter Plant Pug Mills

UNION ARMOR STEEL CASTINGS ARE *TOUGH!*

ANY mill superintendent who has used Union Armor Steel Castings will attest to their toughness. Built to last even under the most difficult operating conditions, these castings are made from a special high-strength alloy steel that insures the very best in performance.

They cost less because they last longer.

"UNION" makes better...

CHARGING BOXES • PEELS • SLAG POTS • INGOT CARS • CHARGING BOX CARS • UNIVERSAL COUPLINGS AND SPINDLES • GEARS AND PINIONS • ALLOY TONGS • SPECIAL ALLOY CASTINGS

CASTINGS CAN BE FURNISHED ROUGH OR MACHINED

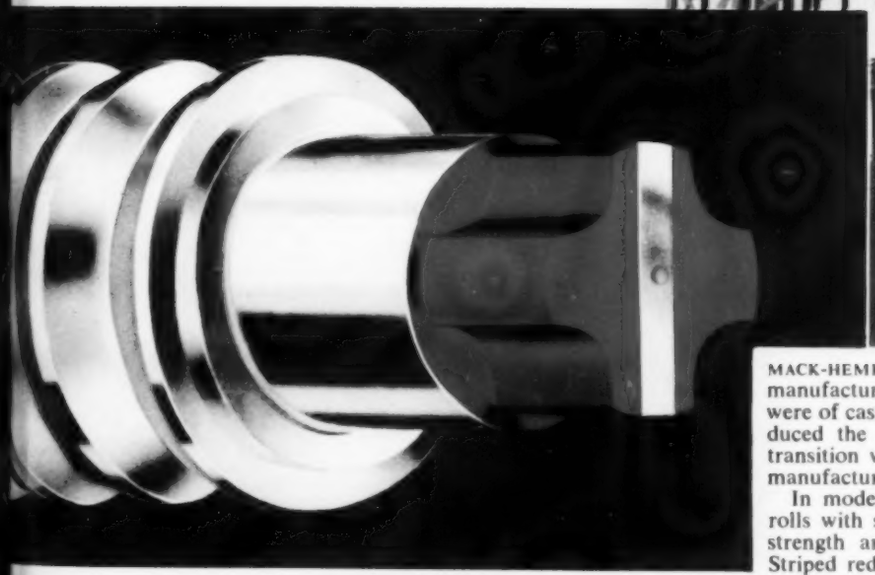
UNION STEEL CASTINGS

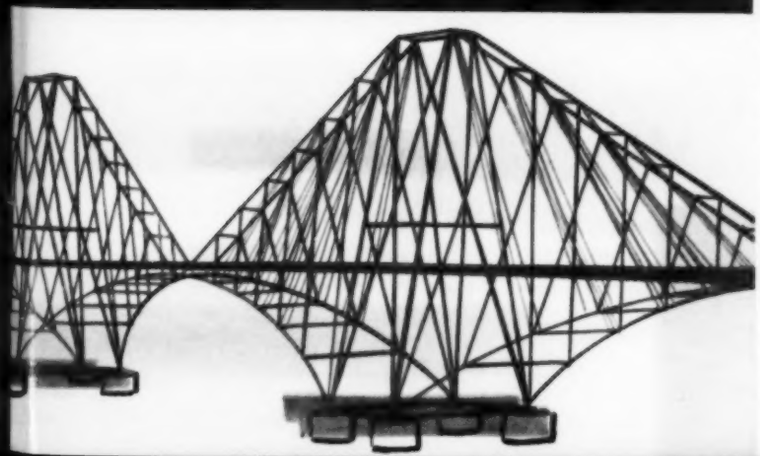
DIVISION OF BLAW-KNOX COMPANY...PITTSBURGH 22, PA.

Structural Shapes

SKELETONS OF STEEL
BRIDGING DISTANCE AND TIME

The first structural beams rolled in the United States were rolled by Peter Cooper at Trenton, N. J. in 1854. These wrought-iron beams, identified as deck beams, were 7" deep and weighed 81# per yard. They were rolled in a mill with three vertical rolls, and were used in the Cooper Union building in New York City. In less than a century, steel mills in the U. S. are rolling more than 4,000,000 tons of structural shapes annually.





MACK-HEMP ROLLS for rolling structural shapes were first manufactured about 1859. In the earlier mills these rolls were of cast iron, but in 1888 Mackintosh-Hemphill introduced the first steel rolls and followed this important transition with many improvements in metallurgical and manufacturing practices.

In modern structural mills, M-H striped red wabbler rolls with special metallurgical structure for high tensile strength are widely used in productioneering practice. Striped red wabbler rolls for structural mill applications include the strong, tough MIDLAND SUPERMETAL, and the high-carbon steel TECHNIKROME rolls.

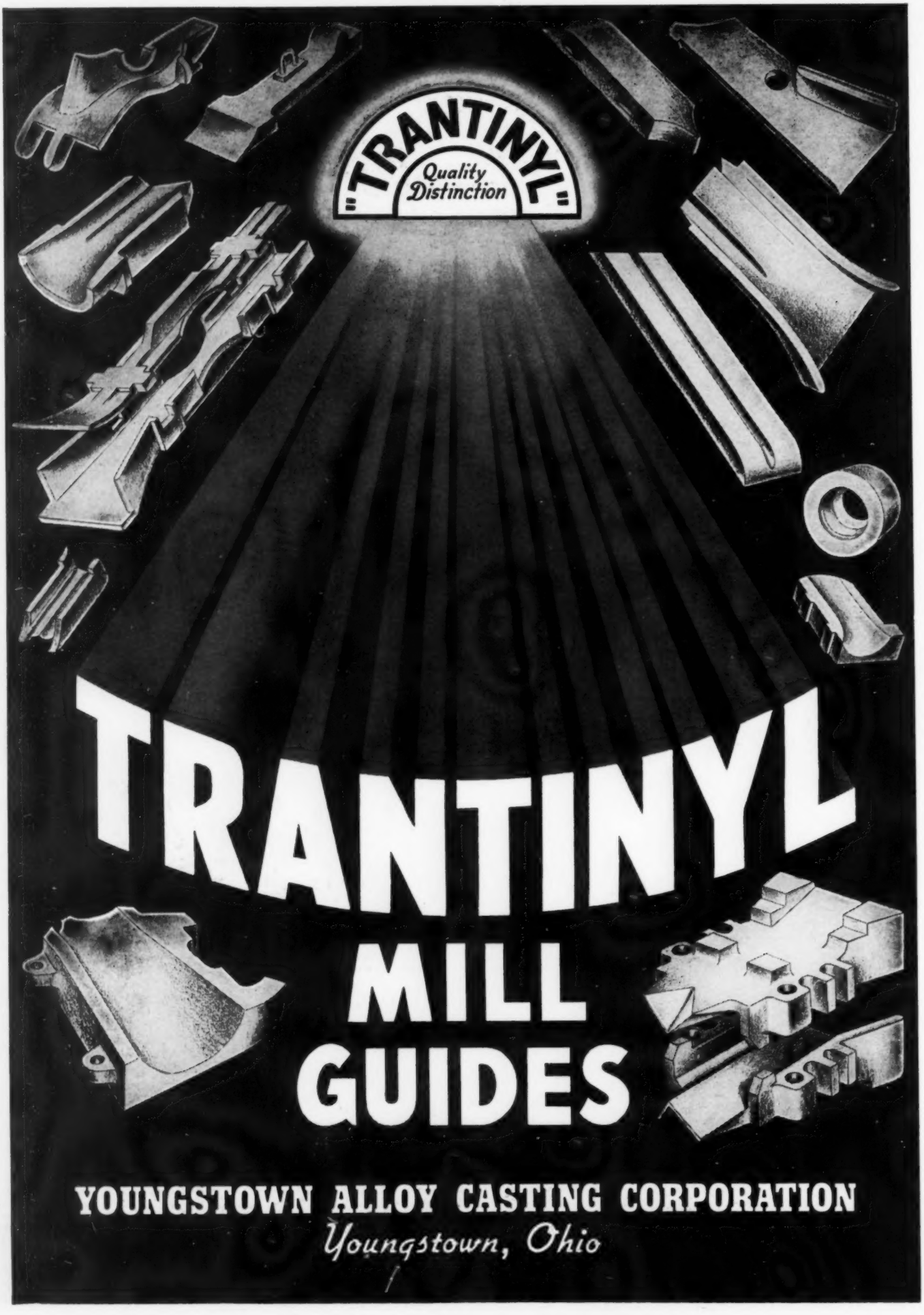
Continuous developments in metallurgical and manufacturing practices make it increasingly important for you to keep an eye on what's new in striped red wabbler rolls at Mack-Hemp.

MACKINTOSH-HEMPHILL COMPANY

Makers of the Rolls with the Striped Red Wabblers

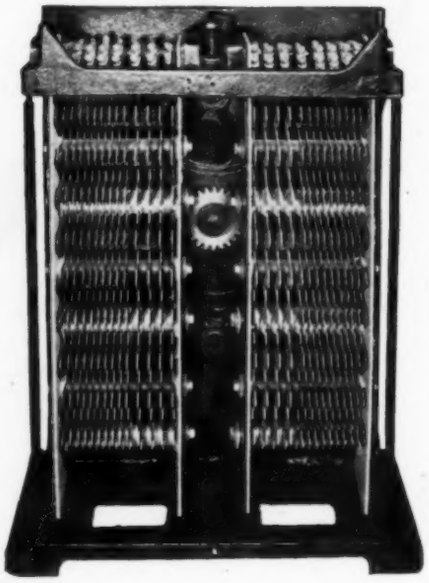
PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Abramsen straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers.


"TRANTINYL"
Quality Distinction
TRANTINYL
MILL
GUIDES
YOUNGSTOWN ALLOY CASTING CORPORATION
Youngstown, Ohio

P-G Steel Grid RESISTORS

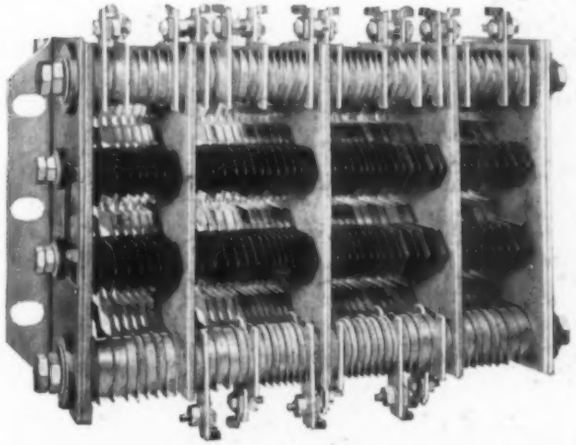
for Internal Mounting In LARGE and Small FACE PLATE CONTROLLERS



Standard units for 5 to 65 H. P. Motors.

Design of the P-G Steel Grid Resistor makes it possible to supply correct ohmic values as well as ample capacity. The ability to meet both of these requirements is assurance of accurate control with full protection to motors using either large or small Face Plate Controllers.

All steel construction, mica insulation, provision for expansion, and ample ventilation combine to produce the exceptional stamina called for by today's production schedules.



Standard units for 2 to 25 H. P. Motors.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

New Sintering Plant...

...NOW *Exceeding* RATED CAPACITY

One of the Nation's Largest!

IN PRODUCTION OF QUALITY SINTER

● THE SINTERING PROCESS is becoming increasingly important to the steel industry, because it permits the *maximum* utilization of iron-ore fines and blast-furnace flue dust. Of equal significance is the effect that sintering has on blast-furnace operation—in greater output, lower coke rate and smoother action.

The modern sintering plant, pictured here, was recently constructed for a midwest steel works by Freyn Engineering Company – a subsidiary of Koppers Company.

This Freyn-Design Plant has two sintering machines. For the steel company's blast furnaces, these machines are now producing good quality ferrous burden at well above rated capacity. This sintering plant is designed to use a variety of raw materials.

Constructing sintering plants is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

KOPPERS

Engineering and Construction Division

KOPPERS COMPANY, INC. • PITTSBURGH 19, PA.

Roll More Tons per pass with PARALLOY

REGISTERED TRADE-MARK

The Quality Name in

PINCH ROLLS
COILER ROLLS
TENSION ROLLS
STEEL MILL ROLLS

No Scratching or Galling

500-600-BRINELL

Also Makers of

DUCTILE IRON

... A Recent and Revolutionary development in the casting industry.

Other Y&T Products

- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—TRAVELING AND LIFTING TABLES
- CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
- FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
- STRIP STEEL COILERS AND REELS—SCRAP BALLERS
- RAILROAD SPIKE FORMING MACHINES—ROLL LATHES
- SHEET GALVANIZING LINES WIRE PATENTING FRAMES
- STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
- ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
- MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

SLAB YARD CRANES

When your Slab Yard Cranes are "Shaw-Box," the plus advantages of experience, advanced engineering practice, and precision manufacturing methods in them insure you efficient low-cost load handling and dependable, trouble-free operation. Simple, rugged, and extremely accessible, they are built to exacting standards of fine workmanship. Wear and resulting maintenance costs are low—even under the most unfavorable operating conditions.

An intimate understanding of mill requirements —gained through years of working closely with the steel industry—has made building Steel Mill Cranes a "Shaw-Box" specialty. Each is an outstanding example of fully interpreted individual mill or AISE specifications—produced at attractive prices.

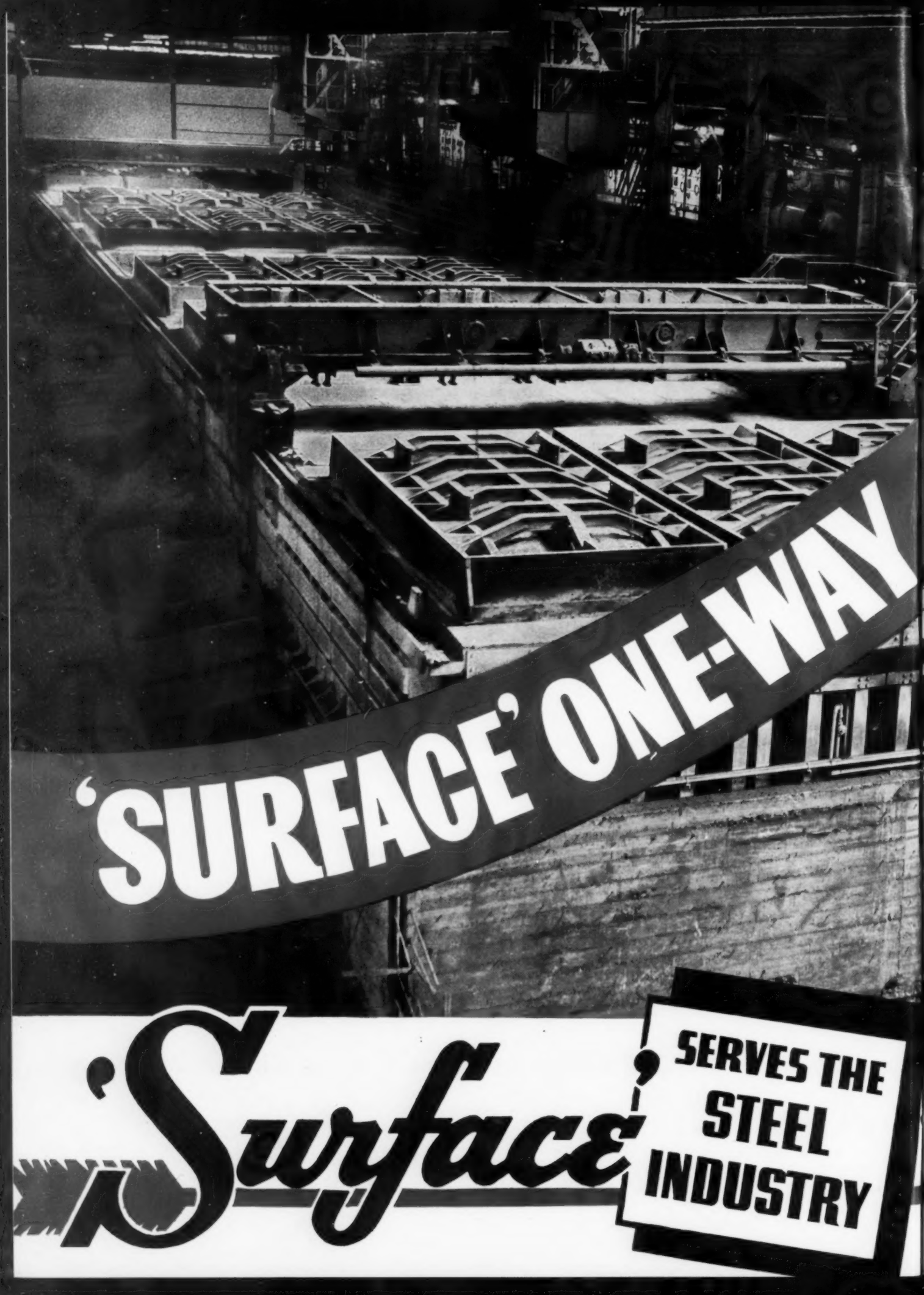
"Shaw-Box" Cranes are recognized in mills all over the country for these qualities and for their record of reliable service and performance.

Be sure to send all your inquiries for Steel Mill Cranes and Soaking Pit Carriages to "Shaw-Box."

MANNING MAXWELL & MOORE INC. MM&M TRADE MARK

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
MUSKEGON, MICHIGAN

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.


'SURFACE' ONE-WAY
'Surface'
SERVES THE
STEEL
INDUSTRY

FIRED SOAKING PITS

IMPROVED COMBUSTION EFFICIENCY!

GREATER FUEL ECONOMY!

• This modern 'Surface' installation in the plant of Wheeling Steel Corporation, Steubenville Works, is the very latest in one-way fired soaking pit design for improved combustion efficiency and greater fuel economy.

'Surface' One-Way Fired Soaking Pits have always been outstanding in their simplicity of construction, and they produce with low operating and maintenance expense. *In addition, 'Surface' has introduced the jet pump recuperative system for improved combustion efficiency.*

If you are not familiar with the latest developments in 'Surface' One-Way Fired Soaking Pits it will pay you to ask your 'Surface' Sales Engineer to explain them to you.

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

FOREIGN AFFILIATE COMPANIES

BRITISH FURNACES LIMITED—CHESTERFIELD
STEIN & ATKINSON, LTD.—LONDON
STEIN & ROUBAIX—PARIS, LIEGE AND GENOA
WILL L. SMITH, S.A.—BUENOS AIRES

One-Way Fired Soaking Pits

Billet Reheating Furnaces

Slab Heating Furnaces

Continuous Type, Controlled Atmosphere Strip Annealing and Normalizing Furnaces

Controlled Atmosphere Annealing Covers for Wire and Rod

Controlled Atmosphere Annealing Covers for Coil and Sheets

Continuous Furnaces for Heat Treatment of Steel Plate

Controlled Atmosphere Furnaces for Carbon Correction in High Alloy Rod and Bar Stock

Continuous Type Bright Annealing and Normalizing Furnaces

Prepared Gas Atmosphere Generating Equipment

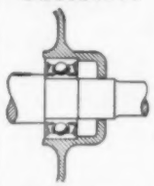
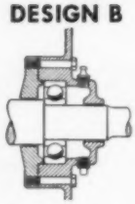
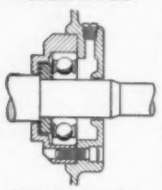
Pit Type Convection Furnaces for Rod Annealing

Stress Relief Furnaces

Wire Patenting Furnaces

"All motors are NOT alike!"

Check these 15 Reasons Why the RELIANCE Bearing Design is the BEST one!

ONLY ONE MOTOR HAS ALL THESE DESIGN FEATURES:	DESIGN A  Prelubricated cartridge—bearing mounted in bracket	DESIGN B  Open bearing mounted in bracket	RELIANCE  Double-shielded, prelubricated bearing mounted in bearing cap
Bearing sealed from dirt and other foreign material	YES	NO	YES
Enclosed bearing housing	NO	YES	YES
Bearing can be relubricated without being disassembled	NO	YES	YES
Motor can be regreased without removing drain plug	**	NO	YES
Automatic grease relief to suit any lubrication system	NO	NO	YES
Protection against grease entering windings	YES	*YES	YES
Balls free of direct pressure during lubrication	YES	NO	YES
Bearing can be removed without danger of distortion	NO	NO	YES
Reservoir to protect against undergreasing	NO	YES	YES
Standard commercial ball bearings	YES	YES	YES
Larger grease reserve than provided with any standard bearing	NO	YES	YES
Grease supply free of churning action	NO	NO	YES
Measuring unnecessary to prevent overgreasing	NO	*YES	YES
Unnecessary to grease equally at each side of ball race	NO	YES	YES
Lubricant is retained in ball race	YES	NO	YES

** Means is not provided for relubrication of assembled motor.
*YES, if drain plug is removed.

The Reliance Pre-lubricated Bearing Design has all of the features vital to maximum motor life. Check these points in the chart at left. The performance of Reliance PRECISION-BUILT Motors in all industries and under all operating conditions has proved their value in long-wearing, trouble-free bearing design.

In most applications, Reliance PRECISION-BUILT Motors operate satisfactorily for years without relubrication. Where it is a practice to grease regularly or where operating conditions make it desirable . . . it is impossible to overgrease a Reliance Motor. Write for *new* Bulletin B-2201 for the "inside story" of the Reliance Pre-lubricated Bearing Design.

RELIANCE Precision-Built MOTORS

Reliance PRECISION-BUILT A-c. Motors from ¾ to 300 Hp.

Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"All Motors are NOT Alike" • 1084 Ivanhoe Road, Cleveland 10, Ohio

Few meters have

ANY *of these features—*

only **HAGAN**

RING BALANCE

has **ALL**

1. No stuffing boxes.
2. Mercury level not critical.
3. Dead-weight calibration.
4. Adjustable over a 7 to 1 range of differentials.

For full information on these meters, or on any application in which you are interested, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN HALL BUROMIN CALGON

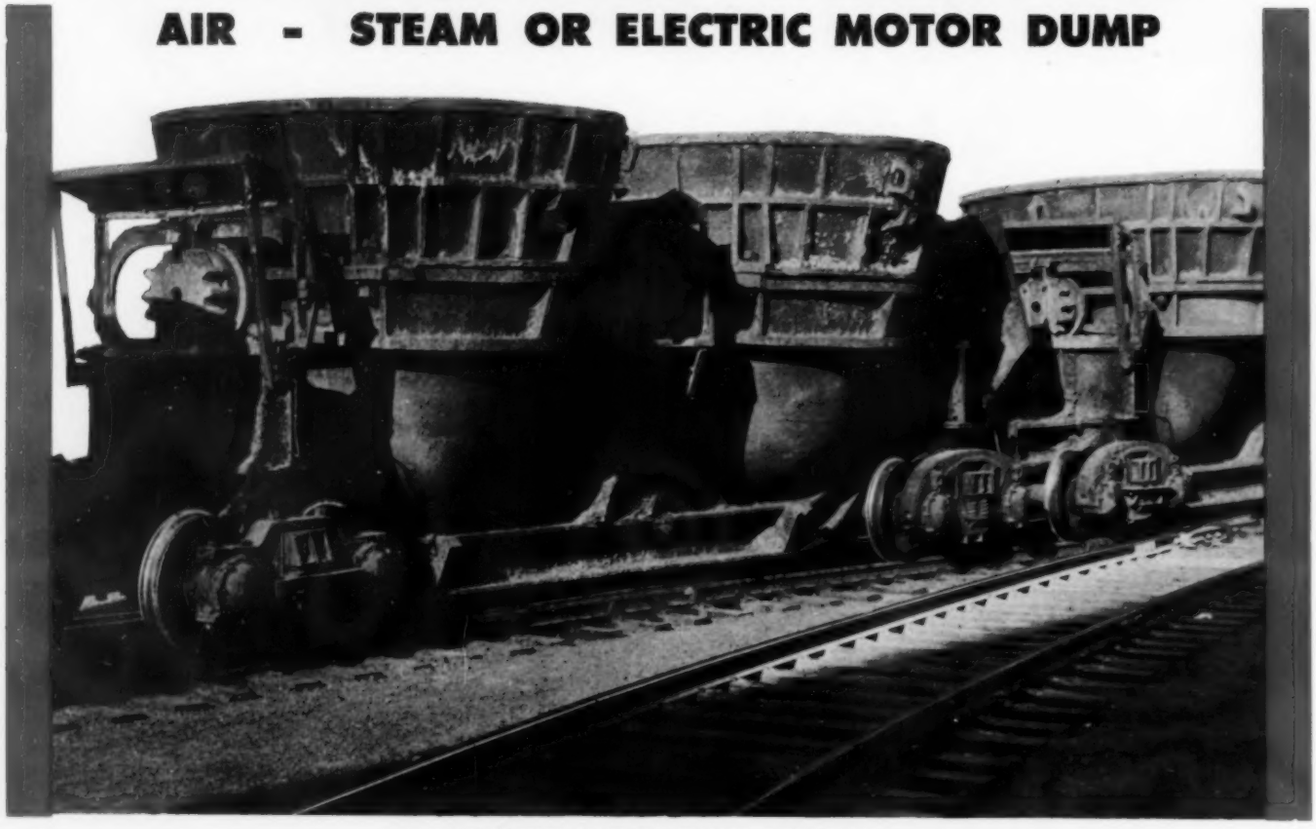
HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

TREADWELL

CINDER CARS

AIR - STEAM OR ELECTRIC MOTOR DUMP



800 CUBIC FOOT TWIN POT CAR

Increased Blast Furnace Capacity

REQUIRES

Additional Cinder Handling Equipment

TWIN POT CARS will enable you to HANDLE 20% MORE SLAG on the same track length

M. H. TREADWELL CO., INC.

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CEntral 6-0784

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WOrth 4-2944

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PITTSBURGH 22, PA.
ATlantic 1-2883

HEAD, WRIGHTSON AND CO., LTD., Thornaby on Tees, England

PENNSYLVANIA ENGINEERING CORP.

NEW CASTLE, PENNA.

LADLES

WELDED or RIVITED

5 to 300 TON CAPACITY

for

BLAST FURNACE

OPEN HEARTH

ELECTRIC FURNACE

BESSEMER CONVERTER

FOUNDRY

LADLE TRANSFER CARS

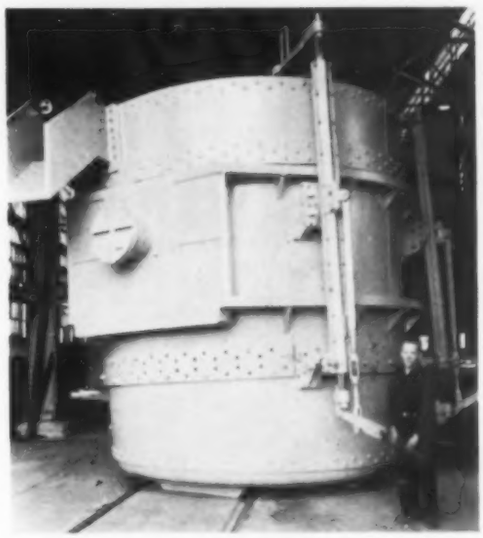
LADLE STANDS

LADLE BAILS

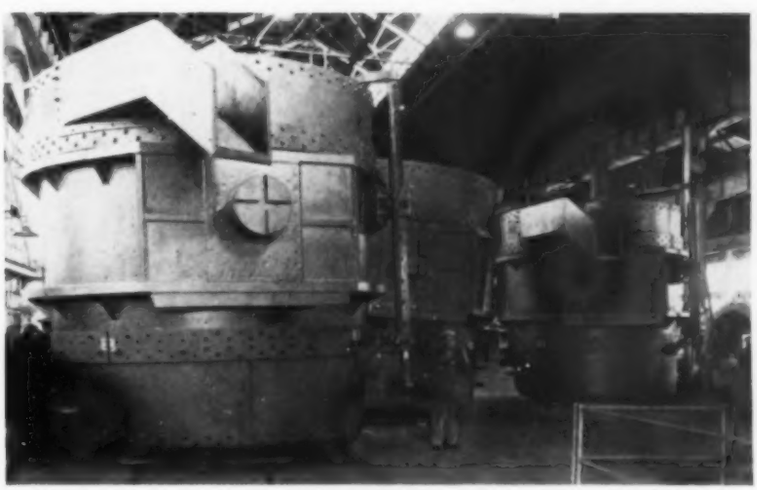
LADLE HOOKS

ALL WELDED LADLES

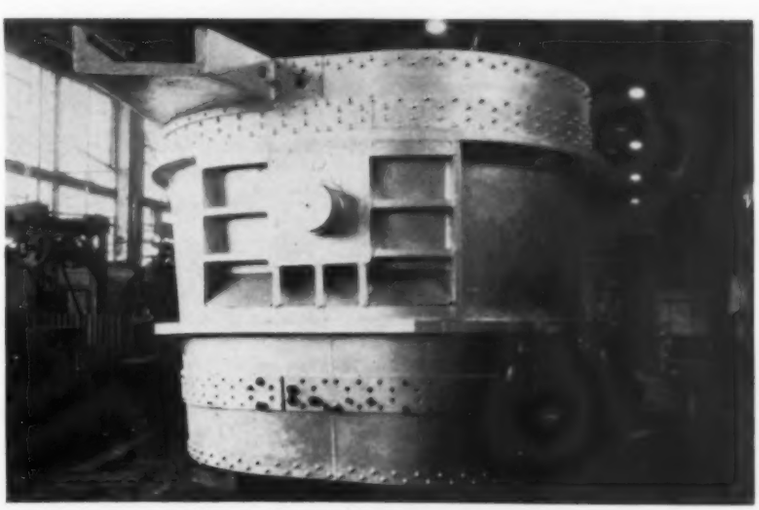
STRESS RELIEVED



225 TON LADLE



250 TON LADLE



300 TON LADLE

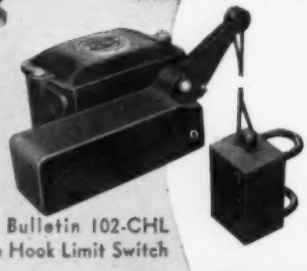
DESIGNERS, FABRICATORS AND ERECTORS OF STEEL MILL EQUIPMENT

CLARK offers ALL CONTROL EQUIPMENT for SAFE, EFFICIENT CRANE OPERATION

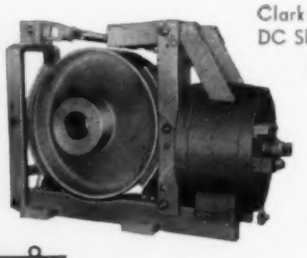
from one reliable source!

CLARK standard crane control gives dependable performance, safe operation and minimum up-keep. All equipment is "tailored" to the requirements of the particular crane. Brake windings, Resistor ratings, Relays, etc. are all built to the specific needs—thus giving immediate use, smooth performance, and top level production.

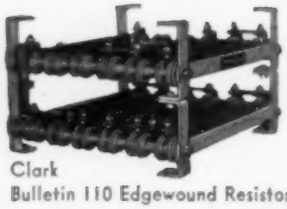
Clark Bulletin 101-RD Master Switch for Mill and Crane Control



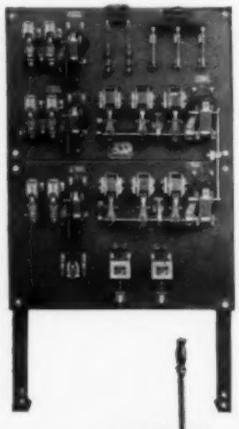
Clark Bulletin 102-CHL Crane Hook Limit Switch



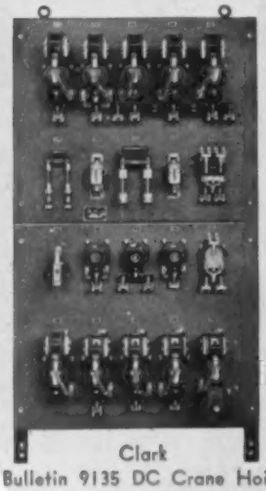
Clark Bulletin 106 DC Shoe Brake



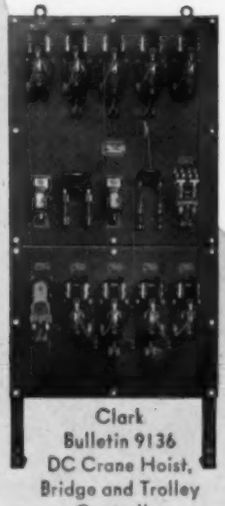
Clark Bulletin 110 Edgewound Resistor



Clark Bulletin 9230 AC Magnetic Crane Controller—Reversing



Clark Bulletin 9135 DC Crane Hoist Controller



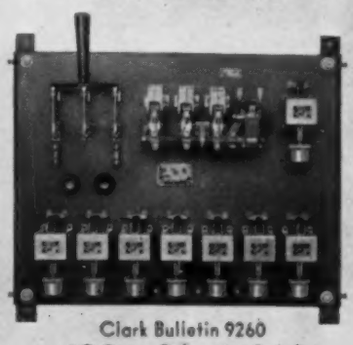
Clark Bulletin 9136 DC Crane Hoist, Bridge and Trolley Controller

Clark Bulletin 9139 DC Floor Operated Crane Controller

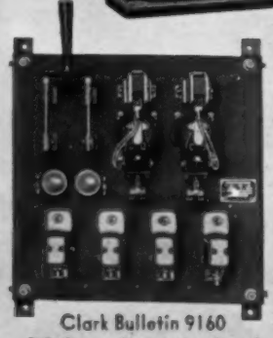
Clark Bulletin 9250 Size No. 2 Reversing AC Manual Face Plate Controller

Pendant Type Push Button Station for Bulletin 9135 Floor Operated Crane Controller

Pendant Type Push Button Station for Bulletin 9135 Floor Operated Crane Controller



Clark Bulletin 9260 AC Crane Protective Panel



Clark Bulletin 9160 DC Crane Protective Panel

FOR COMPLETE *Crane Control* SPECIFY CLARK

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO

LOW COST PRODUCTION WITH

Wide Strip Annealing Furnaces

Increased tonnage with production economy . . . that's the actual experience reported by a leading steel company, operating Drever continuous annealing lines for 42-inch coiled silicon steel strip, pictured above.

Users report consistent, uniform anneal and excellent surface characteristics; resulting in increased stamping die life.

Cleaning is incorporated in the line, thus eliminating a separate operation.

Both quality and low cost production are designed, engineered and built into Drever Wide Strip Annealing Furnaces.

Complete annealing lines for Low Carbon, Tin Plate and Galvanizing stock; also Non-Ferrous strip. Capacities up to, or even exceeding 60,000 lbs. per hour.

View of two 20,000 lb. per hour DREVER CONTINUOUS ANNEALING LINES for 42" wide STEEL STRIP. Delivery end, showing 1820 K. W. Vertical Strip Furnaces and strip recoiling equipment.

P.S.

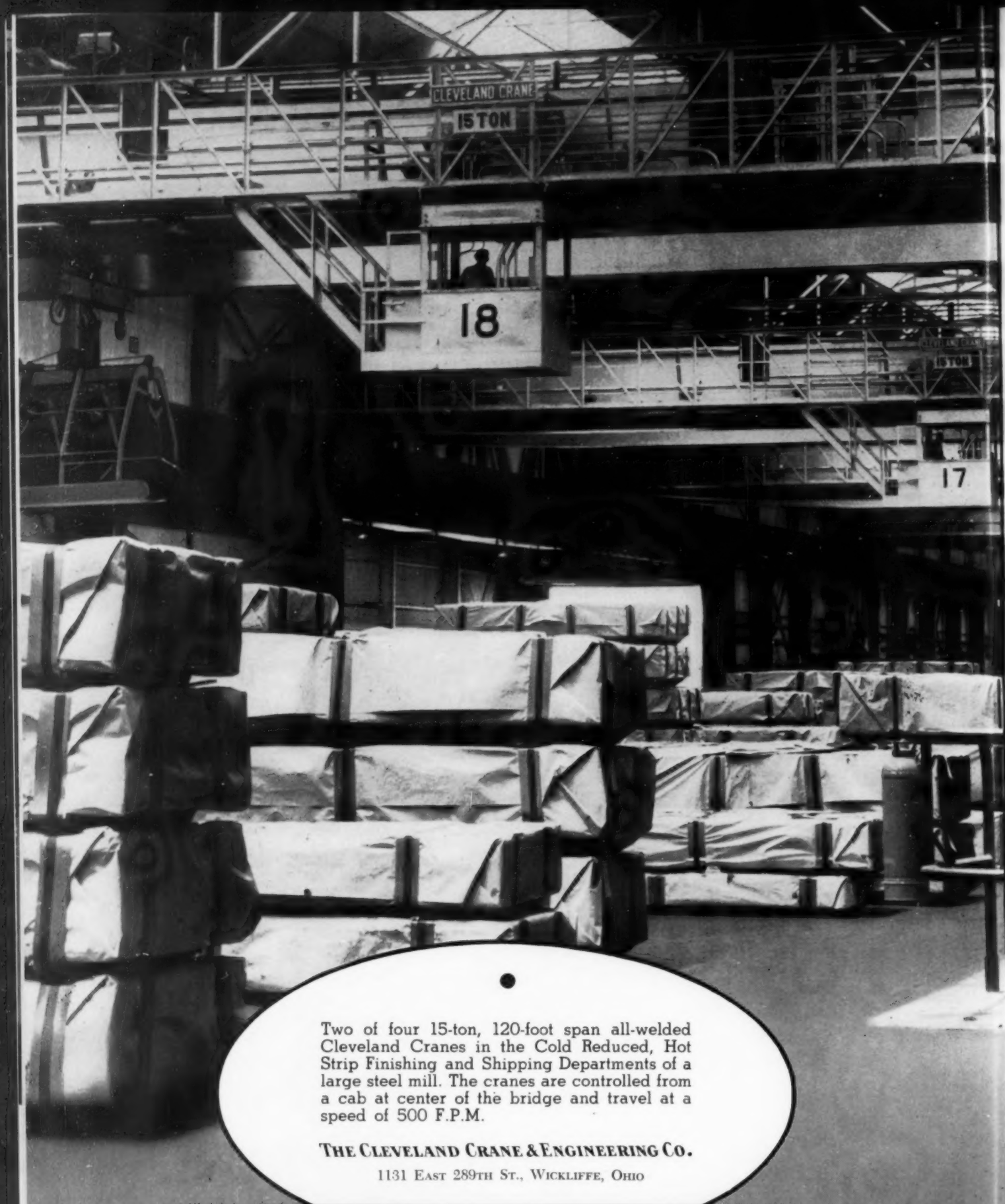
Our many years of experience is available to you, without obligation, in discussing your particular requirements.

DREVER CO.

730 E. VENANGO ST., PHILA. 34, PENNA.

CONTINUOUS FURNACE LINES, HEAT TREATING FURNACES, DESCALING & ATMOSPHERE EQUIPMENT

W. PENNA., W. N. Y. AND OHIO — H. C. BOSTWICK, 1408 S. MORELAND BLVD., CLEVELAND 21, OHIO



Two of four 15-ton, 120-foot span all-welded Cleveland Cranes in the Cold Reduced, Hot Strip Finishing and Shipping Departments of a large steel mill. The cranes are controlled from a cab at center of the bridge and travel at a speed of 500 F.P.M.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 289TH ST., WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts

ACCORDING to various surveys, 1951 will bring record capital spending for expansion in the total industries of the United States. Although the total will break all records, the spending by the steel industry, estimated at $650,000,000, will not equal that of 1948, although it will be about 30 per cent above the 1950 expenditure.

▲

THE steel industry's spending for expansion in the next few years, however, may well exceed the figures that have so far been made public. The annual capacities of 109,963,000 tons of ingots and 73,378,000 tons of iron previously announced as the goals for the end of 1952 have already become obsolete in the planning of the steel industry. These plans, most of which have not yet been announced, point toward an annual capacity of 120,000,000 tons of ingots. A number of projects already in progress will be enlarged materially even before the initial project is finished. The new goal is closely in line with the capacity advanced as essential by various administration officials.

▲

THESE new expansion plans received an encouraging boost through the government's approval of accelerated amortization for Jones and Laughlin's new facilities. The company will be permitted to write off the expenditure in five years, and it is believed the same plan will be approved for other projects.

▲

IT'S just an idle thought, but probably few people realize the full effect of strikes upon the steel industry. We have lost an average of almost 6,000,000 tons of steel each year since V-J day through strikes. At the going rate of $250 - $300 per ton of annual capacity, this means an investment of more than $1,500,000,000 for capacity to make up the strike losses.

▲

PERHAPS steel users who glibly urge the steel industry toward wholesale expansion and point out how much greater their own expansion has been are ignoring some pertinent figures. For example, in 1949, for a given volume of sales, the investment in plants and equipment in General Motors Corp. is only one-third of that in the steel industry. On the other hand, net income in General Motors was 11.5 per cent of sales as compared to the steel industry's 7.12 per cent. Based on either capitalization or net worth, net income of General Motors is three times that of the steel industry.

Putting it another way, in 1949 the steel industry made a profit of $7.01 per ton of steel produced. Today it costs $250 - $300 to install the equipment needed to produce that ton of steel. Not a very attractive investment — at least in comparison with some of those industries who use the steel.

▲

EVER since election day, labor organizations have been giving various reasons for their failure to defeat Senator Robert Taft in Ohio. Of the dozens of reasons advanced, never mentioned is the idea that the majority of the voters really wanted Taft.

▲

SPEAKING of elections, every day the newspapers carry items telling of pending appointments of defeated Democratic candidates to various government posts. If that keeps up, we won't be able to afford many more Republican victories.

▲

IF Moses had been a committee, the Israelites would still be in Egypt.

▲

AS 1950 draws to an end amidst darkening clouds of international tension, the foundation upon which world peace rests seems frail indeed, and the true spirit of the Christmas holidays seems to take on deeper significance. To each and every one of you, and with a fervent prayer for peace, our sincere wishes for happy and joyful holidays and a good new year.

▲

How Many Did You Know?

No one was able to identify all members of this 1914 surveying crew. It was composed of (back row, left to right) B. F. Fairless, Russell Mack, William Smith, and George Fisher; (front row) T. J. Ess and Frank Oberlin. Mr. Fairless is now president of United States Steel Corporation, Mr. Ess is managing director of the Association of Iron and Steel Engineers, and Mr. Oberlin is field engineer for Republic Steel Corporation's District. Mr. Smith is deceased. Mr. Mack is an attorney in Canton, Ohio, while at last report Mr. Fisher was with Great Lakes Steel Corporation. The crew worked on the construction of the Massillon, Ohio, steel plant which is now a unit of Republic.

LINDE'S News of Metalworking

$$$$$$ Saved in Removal of Blast-Furnace Salamander

Oxy-acetylene powder-cutting eliminated a nasty job in one steel mill not long ago. The problem was to remove a salamander in a blast furnace so that the hearth could be replaced without disturbing the upper lining.

After discussing the problem with a LINDE Process Service representative, the company decided to use powder-cutting with an OXWELD C-60 Blowpipe to cut up the salamander.

Only three days were required for the cutting. Production time saved over any other removal method was estimated to be two weeks. $500,000 worth of iron can be produced in two weeks' time.

Most important from the mill's standpoint was the fact that the upper brickwork was not damaged. Damage from other methods of removing the salamander could run as high as $300,000 worth of brickwork.

The OXWELD C-60 Blowpipe is specially designed for extra heavy cutting. And when powder-cutting is used refractory oxides are no problem.

What's News

► Of special interest to quarry men is LINDE'S Jet-Piercing blowpipe which can pierce holes to a depth of 5 ft. in hard and abrasive rocks and ores. This economical, speedy method makes blast holes in granite at a rate of 22 to 25 ft. per hour.

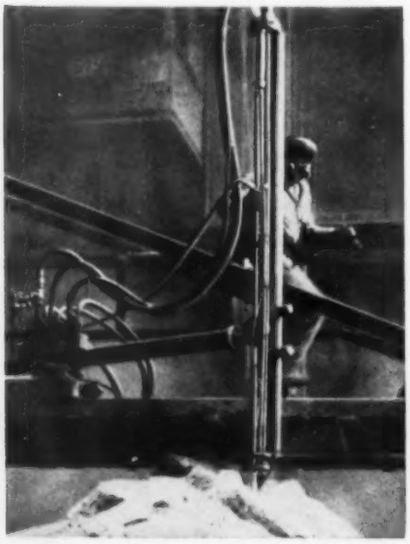
► One pipe manufacturer has produced a record seventy miles of 24-in. pipe (12,990 tons) in one month with the help of UNIONMELT welding.

► By using oxy-acetylene flame-cleaning, a foundry has cut the time required to clean slag from the center of their 20-in. castings from about 6 hours to 5 minutes.

► When television inspectors rejected ten thousand tubes because of cracks in the spun chrome steel bases, LINDE engineers showed the tube manufacturer how to make repairs by HELIARC welding. A saving of $8.00 per tube was accomplished.

LINDE Service Doesn't Cost -- It Pays!

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto



Powder-cutting is used for many jobs in addition to the salamander cutting described above. It is ideal for reducing large masses of cast iron.

"Lost Heat" Reclaimed in 18 Hours

When a full 75-ton heat of steel was recently lost through the bottom of an open-hearth furnace, it was reclaimed in only 18 hours. An OXWELD C-60 Cutting Blowpipe quickly cut the metal to handling size. Using older methods this would have been a three-day task.

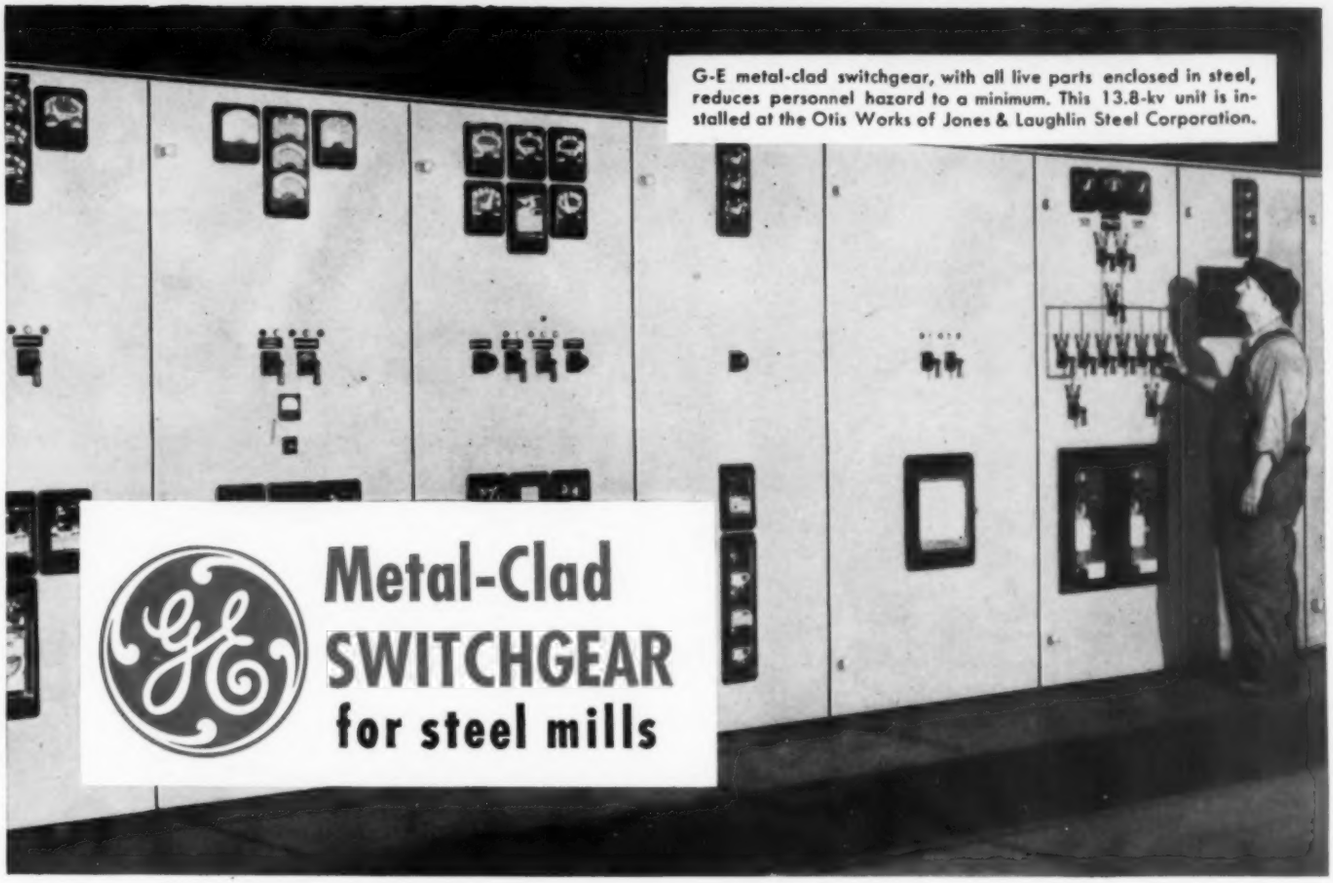
Two full days of operating time were saved by returning the furnace to service in 18 hours. Actual cutting time was only five hours.

And the expense? Total cost for materials amounted to not more than $100.

For further information about powder-cutting or other LINDE processes, call or write our nearest office. We'll be glad to give you more details.

Slag and cinder inclusions are no problem for the C-60 and powder-cutting. Spill sections as thick as 6 ft. have been severed by continuous cutting.

The terms "Linde," "Oxweld," "Unionmelt," and "Heliarc" are registered trade-marks of Union Carbide and Carbon Corporation or its Units.



G-E metal-clad switchgear, with all live parts enclosed in steel, reduces personnel hazard to a minimum. This 13.8-kv unit is installed at the Otis Works of Jones & Laughlin Steel Corporation.

Metal-Clad SWITCHGEAR for steel mills

Cuts installed cost of high-voltage systems

Factory-assembled G-E switchgear adds to the economies of 13.8-kv distribution for large, single-area steel mills.

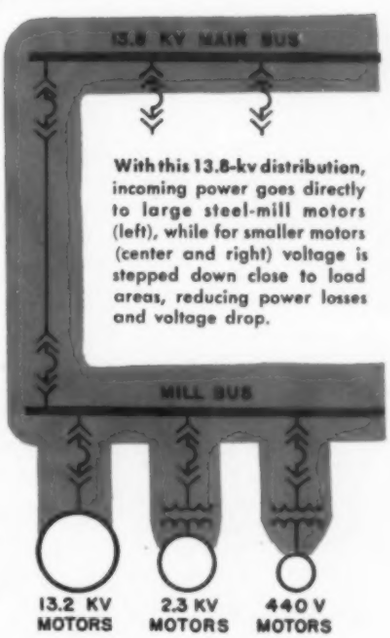
Acceptance of 13.8-kv as a primary distribution voltage—using General Electric metal-clad switchgear—is gaining favor with large, integrated, single-area steel mills.

It is high enough to provide the advantages of high-voltage distribution—lower power losses, reduced voltage drop, lower system cost. And it is also low enough to be applied directly to large steel-mill motors of several thousand horsepower.

Less time, less cost G-E metal-clad switchgear adds many other economies to 13.8-kv distribution. Factory-assembled and shipped to you as a unit, it's installed in less time, at less cost. Metal enclosures protect your personnel. Removable breakers make inspection and maintenance easy. Compact construction saves floor space. And all components are carefully co-ordinated into a complete, efficient unit.

For full information on G-E metal-clad switchgear for high-voltage applications, write today for Bulletin GEA-3083. *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

Ask your G-E representative to arrange a showing of a "Modern Industrial Power Distribution," the full-color sound slidefilm in General Electric's "More Power to America" series.

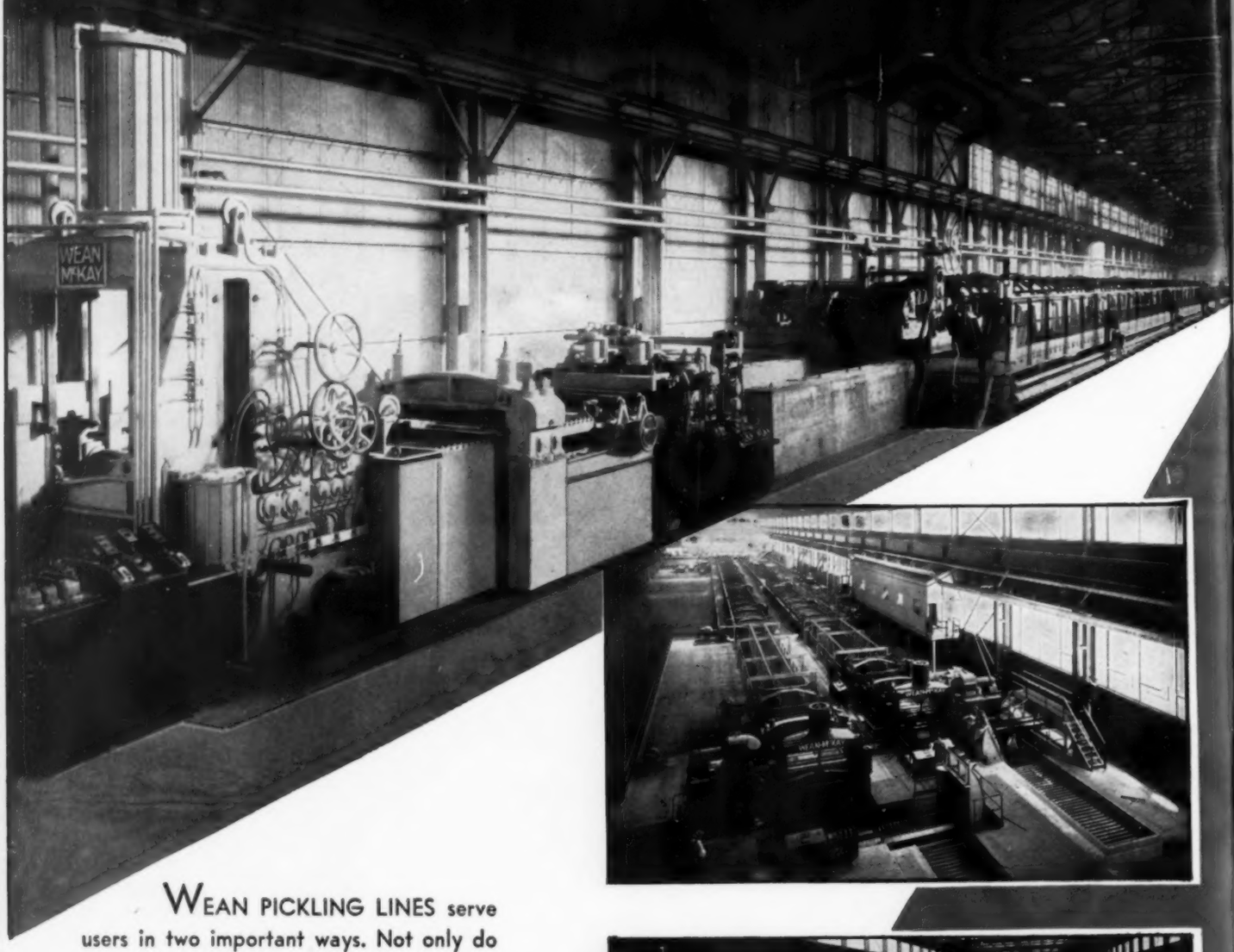


With this 13.8-kv distribution, incoming power goes directly to large steel-mill motors (left), while for smaller motors (center and right) voltage is stepped down close to load areas, reducing power losses and voltage drop.

GENERAL ELECTRIC

659-77

WEAN PICKLING Equipment



WEAN PICKLING LINES serve users in two important ways. Not only do they assure a better — more uniform — pickling job — but the job is done more economically and profitably.

That's why today the majority of steel makers think of Wean when it comes to sturdy, efficient, high production pickling equipment.

THE
WEAN ENGINEERING CO., Inc.
WARREN, OHIO

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Iron and Steel ENGINEER

DECEMBER, 1950 VOLUME XXVII NUMBER XII

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PLASTIC BINDING U. S. PATENT NO. 1779185 LICENSED AND ...

"I'd need labor at 40¢ an hour if we didn't have top charging on our furnace"

This foundry superintendent pays top wages. But he recognizes that, without the time and labor-saving help of his top-charged, Lectromelt Furnace, he couldn't compete. "If we didn't have it, we'd ask Lectromelt to rebuild our furnace to include top charging."

Another user reports that, on a 50-ton Lectromelt Furnace, thirty minutes to an hour are saved on a six-hour cycle, producing 10% more steel on a monthly average. Still another says they top-charge 12,000 pounds in five minutes, compared to thirty minutes with an old door-charged furnace.

Whether your job is melting, refining, smelting or reduction, Lectromelt engineers can tell you how to do it faster and cheaper, while also improving quality. For this help, write Pittsburgh Lectromelt Furnace Corporation, 310 32nd St., Pittsburgh 30, Pa.

Manufactured in . . . CANADA: Lectromelt Furnaces of Canada, Ltd., Toronto 2 . . . ENGLAND: Birlec, Ltd., Birmingham . . . SWEDEN: Birlec, Elektkougnar A/B, Stockholm . . . AUSTRALIA: Birlec, Ltd., Sydney . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa.

WHEN YOU MELT... MOORE RAPID *Lectromelt*

BABCOCK & WILCOX TUBE COMPANY DEVELOPS CONTINUOUS CASTING

By ISAAC HARTER, JR.
Babcock & Wilcox Tube Co.
Beaver Falls, Pa.

. . . . the Beaver Falls Plant of the Babcock & Wilcox Tube Co. was the locale of an inspection trip made by the Pittsburgh and Cleveland District sections of the AISE on April 17, 1950 . . . . the experimental work being done on the continuous casting of steel at this plant is of particular interest to the steel plant operator and engineer . . . .

▲ "ALL types of tubing for all applications," is a statement which particularly applies to the Babcock & Wilcox Tube Co. This company, with plants in Beaver Falls and Alliance, manufacturing both welded and seamless carbon and alloy tubing by virtue of its facilities and manufacturing experience, is in a favorable position to fill demands for any type of ferrous tubing within the dimensional range of its mills.

An outgrowth of the old Pittsburgh Seamless Tube Co., Babcock & Wilcox Tube Co. was acquired in 1907 by its parent, the well-known boiler manufacturer, Babcock & Wilcox Co. Although obtained to run boiler tubing for the parent company only, expansion was so rapid that in 1922 the name was changed to the Babcock & Wilcox Tube Co. and the first sales office was opened in Pittsburgh that same year. Sales growth and with it increased facilities moved along at a rapid pace so that by 1932, three hot mills had been erected. With the addition of these mills, a separate department for hot finishing had to be established in 1938. With the advent of World War II, a steel plant of 5000-ton capacity was erected with two electric arc furnaces supplying the melting capacity. In 1941, the fourth hot mill was added; during the same year the East Works, a second complete cold draw plant was established and the laboratory was expanded for the third time. In 1943, a separate plant for manufacturing electric resistance welded carbon steel tubing was erected in Alliance, Ohio. Known as the Keystone plant, it is one of the few mills in the world set up exclusively for this operation.

Occupying a total of 298 acres with a plant building area of 1,500,000 square feet, the Babcock & Wilcox Tube Co. is well equipped to produce specialty tubing on a mass production basis.

Layout of the four seamless mills is so arranged that the flow is all in one direction ending up in the hot finish department, except for the most recent mill which is located at the opposite end of the hot finish department due to previously limited availability of properly located space.

Primary differences in the four hot mills are in size and movement of billets with respect to billet heating equipment, and in size and method of guiding the billet over the piercer point in the piercing operation. Two of the four mills use a gravity type furnace for heating billets, while the other two use a rotary hearth type, one of which is the second largest and most up-to-date of its type in the world.

Piercers in all four mills are the 60 degree cone type of the company's own design, two of which use stationary guide shoes and two which use rotary discs to guide the billet over the piercer point. Mills No. 1, 2 and 4 have single stand 2-high rolling mills of the normal type followed by reelers which iron-out the internal and external surface of the tubing.

In No. 3 mill, a Diescher elongator replaces the rolling mill and reeler. Developed by B&W, it is one of four in existence today. Somewhat similar to a reeler but with a long bar which replaces the plug on a rolling mill, tapered rolls and two rotating guide discs impart a simultaneous forward and turning motion to the hollow and bar. The size of bar and distance between rolls determines the dimensions of the tube. Size range produced on the hot mills is from 1⅞ in. minimum to 9⅝ in. maximum outside diameter.

FINISHING

Activities of the hot finish department are extremely diversified because of the specialty nature of the business. Some tubes require only straightening, cutting and inspection while others may have as many as 18 different operations performed on them before shipment. In addition to the regular hot finishing operations,

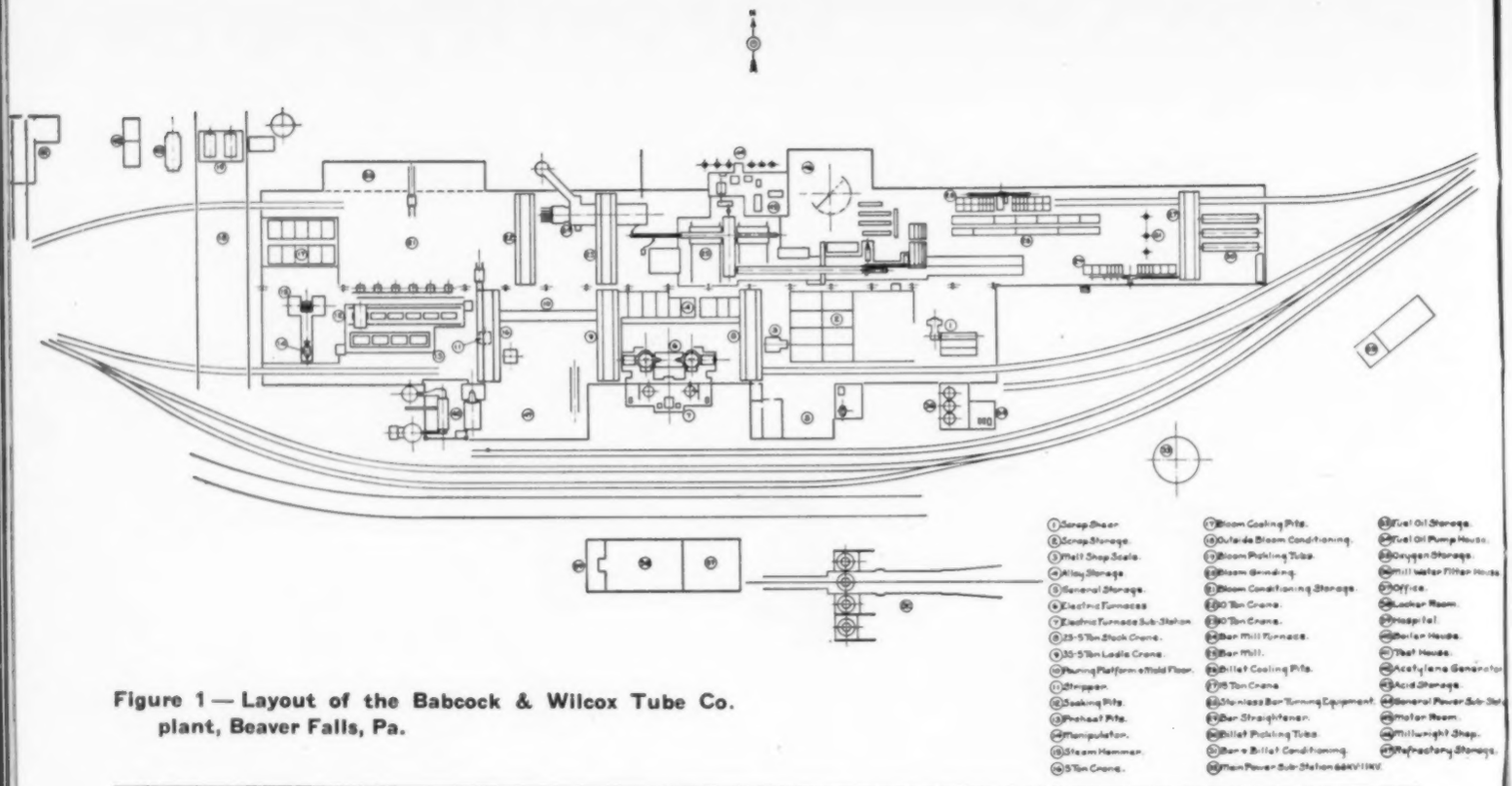


Figure 1 — Layout of the Babcock & Wilcox Tube Co. plant, Beaver Falls, Pa.

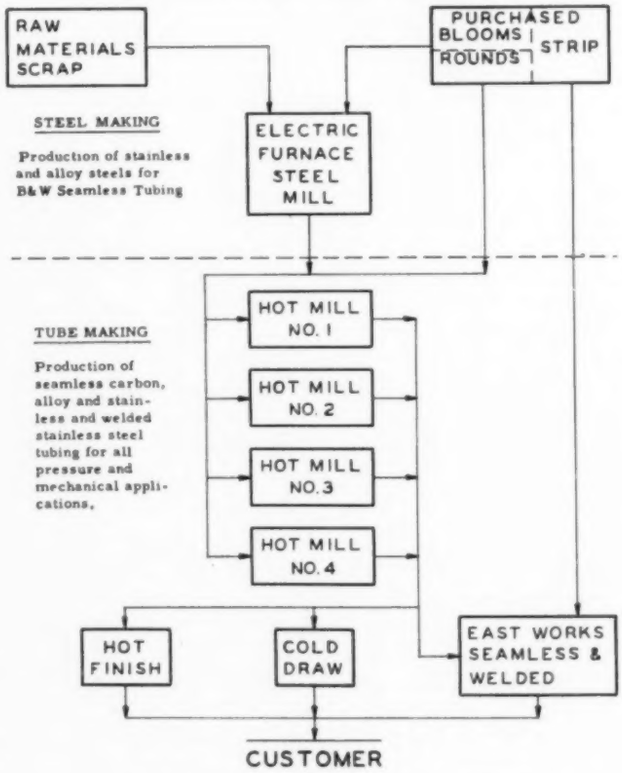
equipment is available for several specialty operations such as turning, centerless grinding, threading, swaging, expanding, etc.

To meet the demand for a wide variety of tube ends, the hot finish operation also includes upsetting. Here the ends are heated in specially designed induction furnaces, and the operation is performed in one of two upsetters used as a single or double stroke forging machine. It should be mentioned here that a battery of car-type gas fired annealing furnaces are used to stress relieve or anneal the tubing for special requirements on hot finished material, or preparatory to the drawing process performed in the cold draw department.

Cold drawing requires extensive preparation before, and a variety of finishing operations after drawing. Two cold drawing units are operated at Beaver Falls, the primary difference between the two being in the sizes handled. Every tube to be cold drawn goes through three general steps, i.e. conditioning, drawing and finishing, with the process differing for various order specifications. There are generally two procedures followed, one for austenitic stainless steels and one for carbon and low alloy grades. Equipment consists mainly of conventional machines for cutting, straightening, grinding and pointing, and facilities for preparing the tube surface for drawing. Utilizing all "one man" draw benches ranging in capacity from 25,000 to 300,000 lb, tubing from ½ to 8⅝ in. diameter in a wall thickness range of 0.028 to 1.500 in. is produced by this method. An example of the extreme dimensional capability was the tubing produced for the U. S. Bureau of Mines for use in the "Gasoline from Coal" project. Drawn on a 300,000-lb bench, the dimensions were 4.780 in. outside diameter by 1.170 in. wall using 16-13-3 (Type 316) material.

To obtain a wide variety of sizes for the bearing tube market, tube reducers are utilized in conjunction with the benches. Fed over a tapered mandrel between rapidly reciprocating roller dies containing a tapered groove, the tube is "rocked" down to the size of the opening between the dies at their small end. Area reductions are obtained as high as 75 per cent in one pass on these machines. Different wall reductions can also be obtained by moving the mandrel in or out.

Figure 2 — Flow of material from the raw to the finished product is shown in this schematic sketch.


RAW MATERIALS SCRAP
PURCHASED BLOOMS ROUNDS STRIP
STEEL MAKING
Production of stainless and alloy steels for B&W Seamless Tubing
ELECTRIC FURNACE STEEL MILL
TUBE MAKING
Production of seamless carbon, alloy and stainless and welded stainless steel tubing for all pressure and mechanical applications.
HOT MILL NO. 1
HOT MILL NO. 2
HOT MILL NO. 3
HOT MILL NO. 4
HOT FINISH
COLD DRAW
EAST WORKS SEAMLESS & WELDED
CUSTOMER

WELDED TUBING FACILITIES

Housed in the "East Works" unit is a welding department where welded stainless tubing is produced on one of three welders by the inert gas shielded arc process. High amperage-low voltage current forms an arc between the tungsten electrode and the edges of the formed strip. These edges melt and as squeeze rolls push them together, they weld with a small, uniform bead. The welded tubing is sized and finally cut to length by an abrasive saw which moves with the tube while cutting. Yield figures on this process are extremely high.

Production of carbon steel welded tubing by the electric resistance welding method is confined to the Welded Tube Division located in Alliance, Ohio. Preceded by facilities for strip preparation such as slitting scale breaking, pickling and cold sizing, two forming mills fold the strip at speeds ranging from 80 to 120 fpm and feed it continuously through the welding mills. Outside and inside beads are trimmed after the tube passes the electrodes, then sized and cut to length by a flying cut-off. Regular finishing operations follow this process. Range of sizes produced is from ¾ to 4 in. outside diameter with wall thickness ranging from 0.049 to 0.188 in. in lengths as long as 60 feet.

CONTINUOUS CASTING PROCESS

Of unusual interest to the steel industry is the development work on continuous casting of steel which is now under way at the Beaver Falls plant of the Babcock & Wilcox Tube Co. This development in steelmaking offers so many possibilities that it will be described in detail in the remainder of this paper.

Many of the inventions of Sir Henry Bessemer have had a profound influence on the iron and steel industries over the past 100 years. Bessemer also believed in the potentialities of continuous casting, but his positive action in this direction was confined (in 1858) to the pouring of a few pounds of malleable iron between a couple of rotating chilled iron rolls. He obtained several dabs of ductile flat metal, and a small piece of this first effort still is dutifully preserved in the museum of the British Iron & Steel Institute. However, credit as father of the art could perhaps be assigned to J. Laing, who more than a decade earlier than Bessemer (1843, patent No. 3043), propounded the scheme of continuously casting soft metal tubing through a mold containing a vibrating mandrel. There is no evidence that any metal was made on such a machine, but the idea was good.

About eight years ago, Republic Steel Corp. at its Corrigan-McKinney plant initiated a development program under the Williams patents (Edward R. Williams, was former president of Vulcan Mold & Iron Co.) and they attacked the problem of the continuous casting of steel. In 1944, Republic entered into informal discussions with Babcock & Wilcox Tube Co. These discussions led to a formal agreement in 1946, when exclusive license rights were acquired under the Williams patents. During the year 1944, the work at Cleveland was discontinued and operations were carried on at Barberton, Ohio, where smaller scale facilities made it possible to determine more rapidly some of the basic experimental requirements. These having been determined, the work was moved to the Babcock & Wilcox Tube Co. at Beaver Falls and embodied in a plant capable of experimenting with the casting of commercial sections, the assistance received on this project from Mr. E. M. Richards, vice president, Mr. E. C. Smith, chief metallurgist, and other Republic personnel has been of untold value.

A riveting tower was obtained for this project and the ladle, pinch (or withdrawal) rolls, transfer car, and some instruments were obtained from the Republic unit. An inductively heated holding ladle was designed and built by the tube company and was powered with a high frequency generator of only 250-kw capacity. The ladle was tilted by a variable speed motor and control. The "tower," as it is called, is the vertical part of the building. Molten steel, melted in the 12-ft electric arc furnace or in the 5000-lb induction furnace in the steel plant, was hoisted to the casting floor and there was bottom teemed into the aforementioned 5000-lb holding ladle. The tilting of the ladle was governed by the manual operation of control rheostats, and metal flowed into a tundish and thence into the mold.

The present tower is higher than necessary. When the project was started, no one knew how fast we could run, how long the mold would be, how much distance would be required for additional cooling or regulated cooling of the casting. We also expected to cut our castings in 35 ft lengths. The floor that is now used for the circuit breaker, furnace tilting control, etc., was formerly used for other experimental equipment and this floor is now extra because in a wider building such as would be used for production, these units could be placed elsewhere. Most of the floors are higher than is necessary and by reducing head room the height of the tower could be further reduced. The distance from the torch floor to the ground is roughly twice as much as necessary and might even be further reduced by use of a different type of handling equipment. The resultant height to the pouring floor would be 35 or 45 ft, that is no more than in some steel mills.

The furnace and equipment on the pouring floor is of the sort that is normally designed for steel mill practice. The withdrawal mechanism, however, would be designed to provide ease and accuracy of adjustment, and the motor would be rated at about 10 hp. The present motor was not designed for these rolls and is actually three times larger than necessary.

The equipment on the torch floor has served its purpose most satisfactorily, but in a production unit the torch would be power driven and be more substantial.

Over 200 heats have been cast in the tower — some of these were cast as 4 in. rounds, some 6 in. rounds, a few were made in rather pointed ovals, and finally the 9 × 4¼ in. oval mold was developed. Approximately 130 tons were shipped to various people for trial purposes, and some of the trial products we made were forging stock, cold drawn and hot finished bars, seamless tubes, strip for welded tubes and wire rope. In all cases these products made by numerous concerns were at least equivalent in quality to their standard products. For the purpose of standardization, economy, and handling one of the hotter types of steel, most of the metal cast was 1020 carbon steel, but several tons of

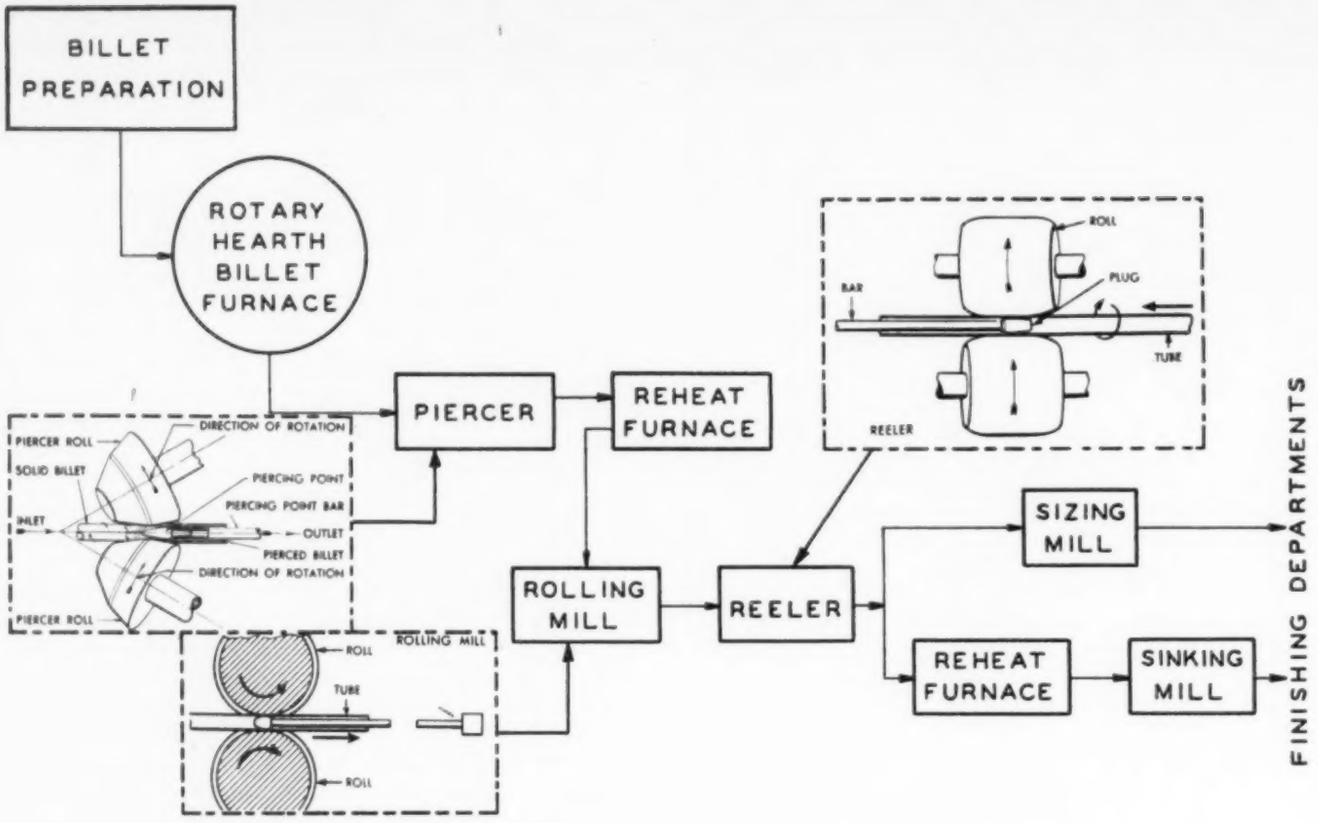


Figure 3 — Schematic sketch of process flow in No. 1 hot mill.

18 chrome, 8 nickel, and 0.70 per cent carbon steel were also cast. There was no difficulty in casting any of these grades, but one heat of 0.06 per cent carbon steel which was practically a rimming heat, was decidedly wild and, although, the heat was cast, it was very porous.

By the summer of 1949, we were able to make good casts whenever we chose and at whatever conditions we desired, but the small induction furnace did not hold enough metal to allow a cast of much more than 15 minutes at the rates at which we were running, and problems of slag and analysis could not be properly settled with this type of unit. Consequently, a 7-ton bath furnace was installed, the largest that would fit in the width of the tower, and it extended the length of the top floor to give reasonable working area. This furnace is of the usual three phase type. The motor speed for tilting the furnace is controlled by an electronic variable speed control circuit. This furnace will enable development of essential information on the life of the refractory lip, slag conditions, and the effect of a prolonged holding time on both analysis and temperature.

This project is quite large for an experimental unit, however, we do not intend to use the unit you saw today for production purposes, and we have plans for a much larger section, about four times the size of the present castings. We must obtain enough information on a varied group of sizes to enable us to estimate more closely the proper speed for sizes that have not been tried. This information will serve as a basis for estimating rates for plants as soon as we decide to release the process as satisfactory for general use.

When we first started on this project, cooling of the mold was a serious problem and several times we poured through the mold wall. Strangely enough, when this occurs, there is not a great explosion but merely a rumbling noise and a shower of sparks coming up from the mold. We made many types of cooling systems utilizing different methods of applying the water to the mold wall. Our present mold is cooled so well that a running stream of molten metal can be directed onto the mold wall without any injurious effects to the mold, and the result is merely a splatter of steel falling into the metal level pool. The continuous rate of heat withdrawal at pool level, that is, at the hottest section, is many times that which has ever been obtained in metal casting. The casting rate, cross section, and area are the determining factors in mold length. The casting is free of the mold wall in several places. The metal starts to develop a substantial wall thickness about ¼ in. below the surface, and as the frozen outer area of the shape in question becomes colder, sufficient strength is developed so that it shrinks and thus is free from the mold. A short time later, the molten interior, in giving up heat by conduction through the frozen metal, and then by radiation to the mold wall, reheats the casting and weakens it so that it expands against the mold. The intimate contact of steel to mold allows more heat to flow from the partially formed casting and it again shrinks from the mold wall. This shrinking and expanding continues until so little heat is left in the molten center of the casting that its periphery remains free from the mold. As the casting proceeds downwardly through the mold, the length of time that

it remains free of the mold becomes longer due to the decrease in the heat content, temperature head, and ferrostatic pressure of the molten metal in the center.

Under these conditions, the heat transfer is greatly reduced, and the mold proper may be terminated at this stage. As heat may be removed more rapidly by direct contact than by radiation, water cooled guides, or other means of direct cooling such as sprays, are used immediately below the mold. The whole problem was frequently complicated by the fact that one of the many independent variables would get out of control just when everything else was lined up to obtain the desired information. Several mold materials have been used and appear to be of more or less equal value, but we have standardized on brass.

The tundish, or slag eliminating container, was one of the problems and is nearly but not yet completely satisfactory. Approximately fifty casts were made in various kinds of bottom pour tundishes, but we finally returned to the lip pouring type, tried in Barberton, and now in use at Beaver Falls. We used almost every kind of refractory material available, and installed nozzles in practically every conceivable manner, but a nozzle would either freeze or erode and thus cause a change in pouring rate in spite of the constant head maintained in the tundish. The present tundish is basically an over-and-under baffle design. We soon realized that if we varied both the pouring rate and the withdrawal rate in order to keep the metal level from either over-flowing or getting so low that the mold length was insufficient for proper freezing, that only highly skilled men could even begin to think of operating at 30 in. per minute, and even they could not outguess the result of these variables for hours at a time. The lip pour tundish and ladle gave us much better control of the variables previously mentioned, and we had considerable success with manual control at rates that did not exceed 30 in. per minute. We have used inches per minute as an evaluator because this factor has considerable bearing on control problems. The faster any process operates, the more essential a control becomes. Speed is also the vital measuring stick for economic operation. With our present control, we have repeatedly run at rates in excess of 60 in. per minute.

When we first started casting, and had developed a good mold, we noticed intense surface cracking in some of the castings. Cracking was first noticed in rounds, and later in shapes whose periphery was not generated with a line of continuously slow changing rate of curvature. In the case of the round, for example, where the frozen rim, or ring, which is in tension while shrinking uniformly in periphery, the ability to shrink may only be satisfied by deformation of shape or internal cracking. Such defects are caused by stress concentration at the point of greatest deformation, and in the case of small rounds it almost always results in a surface crack. Small rounds of good quality have been cast, but not at commercially satisfactory rates. However, in larger sizes of rounds the shrinkage is of more consequence and results in the type of failures outlined above. When the rate of change of curvature is not proper, points of stress are inherent in the periphery of the casting and are, therefore, more apt to create surface cracks. The detrimental characteristics just described, also, occur more on those that are cast at high rates.

The inherent and desirable characteristics of the oval

Figure 4 — Pouring platform where all hot top preparation is handled for steel tube ingots.

shape are its ability to shrink with no detrimental effects, its greater periphery per unit of volume, and the small half thickness for any given total area. These attributes result in both high speed operation and high quality products.

We even have gone so far as to think that complicated shapes may be made if they are designed carefully. The evaluation of the oval section, or rather family of ovals that we have designed, has consumed a great deal of time and effort on the part of many people. Dr. George Sachs, the well known consulting metallurgist from Cleveland, has been a great help in collaboration in this study. His work was done with very rapidly chilled stationary molds in casting a special aluminum alloy and also zinc. With these metals we were able to simulate steel crystal patterns and thus save a great deal of time. Although, this study is not fully completed, we have evaluated the optimum shape for a considerable range of axis lengths and widths. The particular oval shape of the castings made today was agreed upon between Republic and B&W Tube Co. as a compromise shape from which both rounds for piercing and narrow strip could be rolled directly from the casting.

Figure 5 — In the first step of the continuous casting process, molten steel is poured from the transfer ladle into an induction furnace, from which it will be poured into a tundish which is designed to strain out the slag.

We have been continuously casting steel for several years, but as previously mentioned, it was difficult to do by means of visual control of the stream of metal and the level in the mold. We realized that the process, to be economically sound, must be run with ease and assurance of continuous operation. Furthermore, the rate of cooling and rate of withdrawal must be established and held for any given analysis or group of analyses for metallurgical reasons. We, therefore, decided to concentrate on the development of an automatic control of the operation.

Our first system was a cam type of control, wherein the shape of the cam was a lineal representation of the shape of the ladle or furnace. The rate of travel of the surface of the cam, was compared with the actual angular rate of tilting the furnace, and by one of several means these two factors were evaluated and the net result was signalled to the tilting motor as a required increase or decrease in speed. This control system was found to be perfectly sound, but a container for liquid steel could not be built so that it would not change dimensionally during a heat, let alone from heat to heat, as to be radically different from the originally designed shape and, therefore, shape of control cam. This control is of value for other liquids and would work very well indeed on the lower temperature metals which can be held in containers that either do not change shape or at least do not change shape radically and quickly.

The second system devised and used was based on the use of a penetrating ray such as an x-ray beam. The beam was directed across the mold at the desired liquid pool level, and delineated in a preferred vertical range of operation that for example might be plus or minus a few inches from the desired level. The strength of the rays was such that having passed through the water skirt, water, mold, and out the opposite side, the rays could be easily measured in an ionization chamber or other indicating device. As the metal rose above or fell below the desired level, the measuring device produced a decreasing or increasing signal. The variation of this signal from that desired was then made to vary the speed of the tilting motor and thus maintain the proper flow rate.

The third system devised and used was one in use today. This type of control receives periodic signals from the mold and by comparing successive signals evaluates the deviation from a desired level and the rate of approach or departure from a level, subsequently, raising or lowering the tilting motor speed to compensate for the condition that has existed previously.

This paper has discussed the operation of the process and some of the ways by which it has been a success and one may wonder why we are not in production. We have had to verify or disprove so many new theories on the various phases of continuous casting, that we have had only a short time to give to the making of commercial castings. In spite of this, we have produced many tons for production trial purposes. We intend now to concentrate a little more on production so that we can check such things as the very high yield inherent in the process, the larger sizes mentioned previously, and the effectiveness, over long periods of time, of the latest method of eliminating slag from the mold. We hope this additional work will not take too long because we are as anxious as the many people who already want to use this process.

THE PHYSICAL CHEMISTRY OF STEELMAKING*

▲ AT the present time the American Iron and Steel Institute is sponsoring further research in steel making and the principal projects are listed in the following:

1. Equilibrium in the distribution of sulphur between slag and metal has been studied for slags of blast furnace type covering a wide range of compositions. Results for simple iron-carbon-silicon-sulphur alloys have been published by Hatch and Chipman (Journal of Metals 185, 284, 1949), and by Sherman and Grant (Journal of Metals 185, 898, 1949). The effect of other elements, especially manganese, on the equilibrium and rate of removal of sulphur has been studied. Current work includes the effect of silicon and a study of the equilibrium distribution of silicon between slag and metal.

2. The distribution of chromium between liquid steel and slags of the open hearth type is being studied. This study is aimed at understanding the recovery or elimination of chromium in basic open hearth operation.

3. The desulphurizing power of basic electric furnace steel slags, including the conditions for formation and decomposition of calcium carbide and its effect in deoxidizing or desulphurizing the metal, is being examined. The distribution of oxygen and sulphur between liquid iron and slags of low iron oxide content was measured.

4. It is planned to conduct a study of slag constitution based on electrical conductivity measurements. Most of the previous work has been done on silicate slags, and a study at high temperatures of the basic side of slag compositions beginning with pure CaO has been begun.

5. A number of experimental measurements have been made, but analyses are not yet complete. It is hoped that the data will be sufficiently reproducible to establish the heat of solution of aluminum and of nickel in iron.

6. A study is being made of the thermodynamic behavior of carbon in liquid steel, utilizing a method of gas-metal equilibria. This has a direct bearing on the reactions of carbon with open hearth slags. Compositions to be covered include very low to very high carbon and the effect of alloy elements.

7. The ternary system FeO-Fe_2O_3-SiO_2 is the basis of several metallurgical slags, including those produced in copper smelting and in acid steelmaking processes. Also, a knowledge of the phase relations in this system at high temperatures is desired to explain some aspects of the behavior of silica refractories in the presence of iron. The system is being studied by the technique of quenching and microscopic examination.

*Abstracted from paper of same title presented by K. L. Fetters, Assistant to Vice President, Youngstown Sheet and Tube Co., at Pittsburgh Regional Technical Meeting of AISI, October 11, 1950.

DEVELOPMENTS IN THE DESIGN OF D-C MOTORS *and* GENERATORS FOR ROLLING MILLS

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. . . . the increases in operating speeds and efficiency of rolling mills have been largely dependent on developments in the motors and generators which drive them . . . .

▲ PHENOMENAL advances in steel rolling techniques have been made during the past decade. Delivery speeds for tandem, cold strip mills have been greatly increased from some 3800 to 6200 fpm. Rod and tube mills have been greatly improved to increase production, to improve quality of product, and to reduce scrap. Extended use has been made of electric drive for fast reversing mills for rolling blooms, slabs, and plates both for new mills and for replacement of steam engine drives.

These advances have presented a challenge to the designer of d-c motors and generators. In order not only to meet this challenge but also to anticipate and be prepared to meet future requirements, many important developments have been made in the design of such equipment. As an illustration of the scope of this work some of the more important contributions will be described.

ROD AND TUBE MILL MOTORS

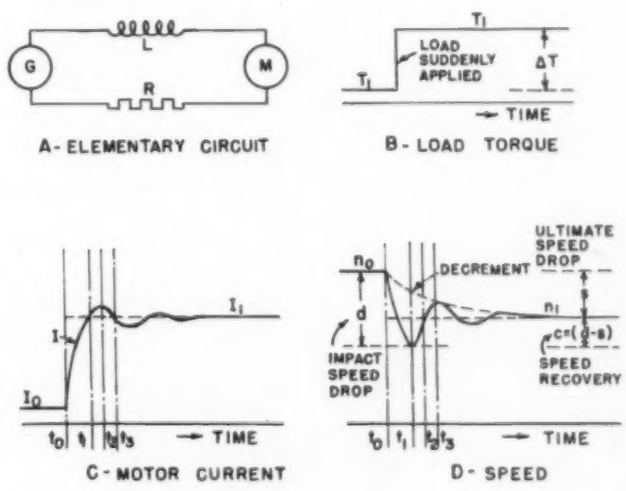
Reduction of scrap and improvement of product quality are objectives toward which engineers are constantly striving. For rod and tube mill applications this had led to investigation of the transient speed characteristics of the driving motors. The theory involved and the method for calculating performance with known motor characteristics have been described in earlier papers.[1], [2], [3] *

Of particular concern are tandem mills with separate motors for adjacent stands. Here very close synchronization of relative motor speeds is required. This can be obtained very readily for steady-state load conditions by proper adjustment of the fields of the motors. As the rod or bar enters the rolls, load is suddenly applied to the motor and the speed of the motor will drop. The speed drop may exceed the steady-state speed drop, in which case a recovery of speed will follow the initial drop. In extreme cases several oscillations in speed may occur. It is during this period that improper speed relationship will exist between stands with the net result of "ballooning" or "stretching" of the finished product.

Figure 1 is taken from an earlier paper[1] to illustrate motor performance during the transient period and to aid in defining terms. Of primary interest are the impact speed drop, d; the steady-state speed drop, s; the ohmic or IR drop in the armature circuit of the motor; and the ratio, $m = d/IR$.

Motor performance, if the motor is properly adjusted, is readily determined from the chart[3] of Figure 2. The time constant, $T_i = \frac{L}{R}$, can be thought of as a property of the electric circuit. This is the constant which describes the build-up or decay of current in a simple inductive circuit such as a solenoid. The time constant,

Figure 1 — Diagrams illustrating fundamental behavior of d-c motors driving individual stands of a continuous mill.



* Numerals refer to Bibliography at end of article.

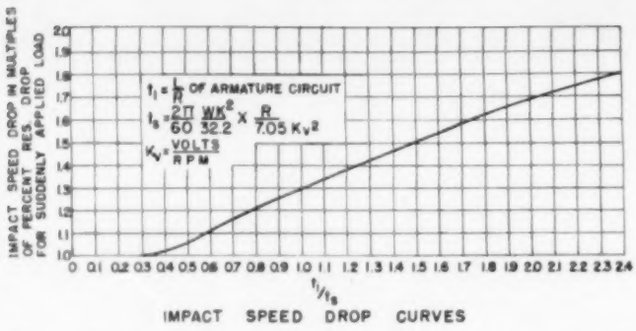
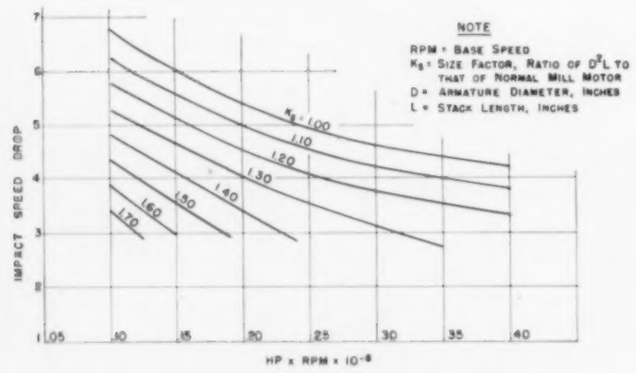

IMPACT SPEED DROP IN MULTIPLES OF PERCENT RES. DROP FOR SUDDENLY APPLIED LOAD
$t_i = \frac{L}{R}$ OF ARMATURE CIRCUIT
$t_s = \frac{2\pi}{60}\frac{WK^2}{32.2} \times \frac{R}{7.05\,K_v^2}$
$K_v = \frac{VOLTS}{RPM}$
t_i/t_s
IMPACT SPEED DROP CURVES

Figure 2 — Impact speed drop is given as a function of time constant.

$t_s = \frac{2}{60}\left(\frac{WK^2}{32.2}\right) \times \left(\frac{R}{7.05\ K_v^2}\right)$ can similarly be thought of as mechanical in nature, since it relates to the stored energy and the steady-state speed. The electrical time constant, t_i, evaluates the delay in building up current in the armature of the motor, hence the time delay in developing electrical torque. The mechanical time constant, t_s, evaluates the ability of the motor to develop torque from its supply of stored energy with loss in speed. It is, therefore, logical that the ratio, t_i/t_s, should prove to be the important factor in determining the ratio, m, of the impact speed drop to the IR drop. The impact speed drop is then the product of the IR drop and the ratio m, all quantities being expressed as per unit values.

It is normally considered that best operation results when the steady-state speed regulation is adjusted to be very nearly equal to the IR drop. This means that there is no net change in the main field flux with change in load, and no consequent relatively slow change in speed, which if present would persist for a second or so. Some difficulty is encountered in accomplishing this at all speeds from base to top speed for a variable speed motor. Commutation conditions change with speed, which causes the small amount of compounding resulting from cross-magnetizing effect of armature reaction to be slightly different at the base and top speeds. However, careful adjustment can minimize this effect, and it is practical to adjust so that within practical limits the speed regulation can be made equal to the IR drop at both base and top speeds.

Figure 3 — Impact speed drop of d-c mill motors is given as a function of rating and size.



Ideal conditions result when m is unity; that is, when the impact speed drop is equal to the IR drop. As a practical matter, values of m up to 1.25 can probably be tolerated for most cases. This means that there will be some slight oscillation of speed. Conditions will be worse at base speed, and will improve rapidly with increased speed. Thus, a motor which has a value of 1.25 for m at base speed will have a value of 1.05 at a speed corresponding to 1.35 times base speed. Reference to the equation of Figure 2 will show how m varies with the machine constants. For fixed values of R and K_v, the value of m approaches unity as the armature circuit inductance, L, decreases and as the motor WK^2 increases. In general any major improvement of either of these constants requires a larger machine, although some appreciable improvement compared with the standard motor can be made through skillful design. In extreme cases the use of a separate flywheel may be indicated.

The value of IR drop is the primary consideration. A low value is desirable, and material reductions can be obtained only at the expense of more copper in the windings and a larger machine. It becomes, therefore, largely a question of economics. In other words, improved performance can be obtained through the use of a larger, more expensive motor.

In order to make the choice of motor on a reasonable basis, it is necessary first to know what performance to expect from the normal motor and second the rate of improvement as the physical size and cost of the motor are increased. Such data is given in Figure 3. It may seem odd at first glance that the impact speed drop is plotted against the product of (HP) (RPM). However, there are good basic reasons for this, and it was found through trial that the data correlated quite well on this basis. This means, for example, that a 500-hp motor with a base speed of 500 rpm tends to have the same impact speed drop as an 1000-hp motor with a base speed of 250 rpm, since both have a product of (HP) (RPM) of 250,000.

It is of interest to note the impact speed drop is low for high values of (HP) (RPM). The converse is also true. Thus, it is quite possible that for a large, high speed motor the impact speed drop for the standard design will be satisfactory, and it may not be necessary to use a premium motor. For a small, low speed motor a considerable increase in size may be required in order to get comparable performance.

The design of such motors has presented a new emphasis to certain of the design constants. It has been necessary to develop improved methods for calculating and measuring the inductance of the armature circuit. Methods for reducing the inductance have been studied and progress made. The problem is somewhat complicated by the fact that a simultaneous reduction in resistance is required, and these two objectives are in many cases contradictory.

Since it is the total resistance and inductance of the armature circuit which determines motor characteristics, it follows that attention should be given to the generators and transmission cable or bus. Common practice is to use a main generator bus feeding several motors, so the generator capacity is large compared with any one motor. This means that the resistance and inductance of the generators is normally quite small

compared with the motor. The contribution from the bus or cable can also be kept small by giving proper consideration to physical arrangement, spacing of two polarities and length of run. In a well-designed system the contribution from other parts other than the motor can usually be neglected.

A number of tandem rod mill equipments have been placed in service using motors of special design. In most cases such motors have corresponded to a size factor, $K_s = 1.15$. In some cases where the performance of the motor was considered to be highly critical, the design has been based on a lower value of impact speed drop. Reports from these mills indicate quite successful performance, and seems to validate the analysis of the problem and the method of design.

Of particular interest has been the installation of two tandem tube mills. The photograph of Figure 4 shows one such mill in the construction stage. The motors are located in the pits to the left and right of the tandem mill. For a total of nine stands for 1500-hp, 375/750 rpm, and five 500-hp, 375/750 rpm motors were used. These motors were designed for impact speed drop and armature circuit resistance drop not to exceed 2½ per cent. Operation of the mill has proven successful, and motor performance has been up to expectations.

TANDEM COLD STRIP MILLS

For this service, the strip is threaded into the mill at low speed, is placed under tension, and then the mill is accelerated very rapidly to running speed by voltage control. During this period it is desirable to have as little change as possible in the reduction in gage at each stand and in the tension in the strip between stands. This permits rapid acceleration of the mill with a minimum amount of off-gage steel at the ends of the coils. Rapid retardation under correct tension is also important for the same reason at the end of each coil.

Of the motor design constants which contribute toward good performance, the most important are: (1) the motor inertia, WK^2; (2) the ohmic or IR drop in the armature circuit; (3) the steady-state speed regulation; and (4) the degree to which the transient and steady-state characteristics are matched. Although these characteristics are inter-related, for the purpose of this discussion they will be discussed separately.

Motor inertia—A low value of motor inertia is required. If zero inertia of the rotating parts could be achieved, then the current drawn by the motors for any particular rolling schedule would be a function of mill speed only and would not vary with the rate of acceleration of the mill. Obviously this would simplify the control and would be a major step toward making the motor characteristics the same for slow and fast changes in speed. The perfect cannot be realized, but much effort has been directed toward keeping the WK^2 to a low value.

The problem here is best illustrated by reference to two approximate but basic design equations. First there is the well known relation:

$$\text{Torque} = \frac{HP}{RPM} = K_1 D^2 L, \qquad (1)$$

where D is the diameter at the air gap, L is the length of active iron of the rotor punchings, and K_1 is a constant. For a specific value of K_1, this equation is valid only for a limited range of machine sizes and for machines having the same temperature rise, method of ventilation, and peak overload. For a variable speed motor, the base value of rpm is used.

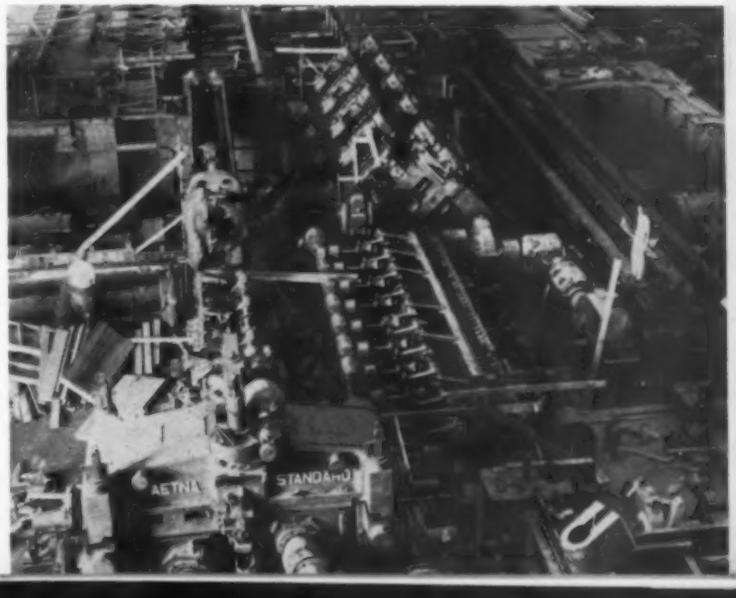
Equation (1) applies equally well, with perhaps a slight modification of the value of K_1, to synchronous and induction motors as well as d-c. The relationship between D and L for a particular rating in the case of a-c motors is largely a matter of ventilation, mechanical and economic considerations. However, two features of the d-c machine lead to another basic design relation. First, there is the design constant which is a measure of the ability of the machine to commutate successfully. This constant is referred to as reactance voltage of commutation. Second, there is the voltage between adjacent commutator segments *(volts per bar)*. Since it is necessary to bring the armature coil connection out to a commutator, it is necessary to sustain this volts per bar across the creepage surface of the side mica between commutator segments. Thus, a rather low limit is placed on this value in order to minimize the possibilities of arcing between segments and flashover. As a result of these additional limitations, a second basic design equation exists which is peculiar to d-c machines. It is:

$$\text{Minimum gap diameter} = K_p \text{ (HP)}. \qquad (2)$$

Again K_p has significance as a constant only for machines rated on the same basis as to temperature rise, ventilation, peak load and speed range. Also its value will change with a change in the limiting value of volts per bar. If this limit is raised, the gap diameter can be made smaller. The type of armature winding has a material influence on the value of K_p. The higher the ratio of the number of parallel paths in the armature winding to the number of poles, the smaller the minimum gap diameter. Higher speed range, lower temperature rise and poorer ventilation all increase the minimum gap diameter.

For a typical rating with forced ventilation, 40 C rise, 200 per cent maximum momentary load, 2:1 speed range, average value of volts per bar over complete

Figure 4 — Photograph shows installation of motors on 9-stand continuous rolling mill at the National Tube Co., Lorain, Ohio.



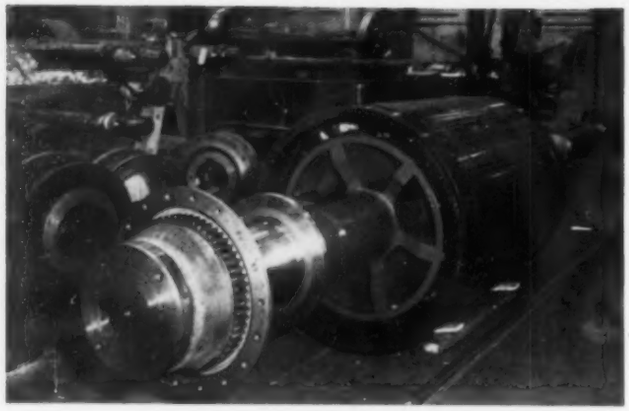


Figure 5 — Shown in detail is the integral shaft and spider on 1750-hp 175/350-rpm, 750-volt, 8-pole, low inertia, forced-ventilated, d-c motor for tandem cold rolling mill.

pole pitch limited to 18, and with a conventional multiple drum or lap winding having the same number of parallel circuits as poles, it is possible to build a 2000-hp motor on a 54-in. diameter, and get satisfactory performance. The use of a newly developed armature winding makes it possible to reduce the minimum diameter materially in many cases.

Thus far mechanical limitations have not been considered. For a slow speed, high torque but low horsepower motor, the shaft and other parts become quite heavy. If the minimum diameter from equation (2) is used, the resulting length of stack, L, from equation (1) may be found to be excessive. In this case it may prove impossible to get sufficient space between the shaft and armature punchings for suitable ventilation. A larger diameter than the minimum value is then indicated.

For high speed motors the mechanical limitation appears differently. Here it is a matter of centrifugal forces on the armature winding and other rotating parts. The peripheral speed or product of RPM x Diameter is an approximate measure of the limitation imposed here. Then from equation (2) it follows that the product of HP x RPM is limited to a maximum value. The speed range enters this relation very nearly as a direct factor, so for ratio, A, of top to base speed, the limitation may be stated as

$$\text{Maximum value HP} \times \text{RPM} \times A = M. \qquad (3)$$

An economical, practical limit for peripheral speed is 10,000 fpm, and on this basis the typical 2000-hp motor described above would have a maximum speed of 700 rpm. Thus, the limiting value of $M = 2000 \times 700 \times 2 = 2.8 \times 10^6$. The value of M can be increased somewhat without exceeding safe values of performance constants, such as volts per bar and reactance voltage, by increasing the peripheral speed. This normally entails a more costly design, and requires careful consideration of mechanical problems. More promise is offered by the newly developed armature winding. With its use, successful operation has been achieved for a motor of this class having a value of $M = 3.6 \times 10^6$.

The desire to keep the motor inertia low leads to the use of the smallest possible diameter, consistent with good performance. This has placed emphasis on ventilation, and the use of such developments as the integral shaft and spider. This provides for a maximum space between the shaft and punchings for ventilation. See the photograph of Figure 5. The use of multiple units is another method of reducing the inertia, since two half size motors can be built with a lower inertia than can one full size, larger diameter motor. Such an arrangement is shown in the photograph of Figure 6. Possibly the ultimate in this direction is illustrated in the photograph of Figure 7 which shows four armatures for a single stand.

Not only is a low value of inertia desirable, but there are advantages in having a proper balance of values for the motors driving the various stands of a tandem mill. This is another step toward relieving the control of an additional correction burden, and attention to such refinements pays dividends.

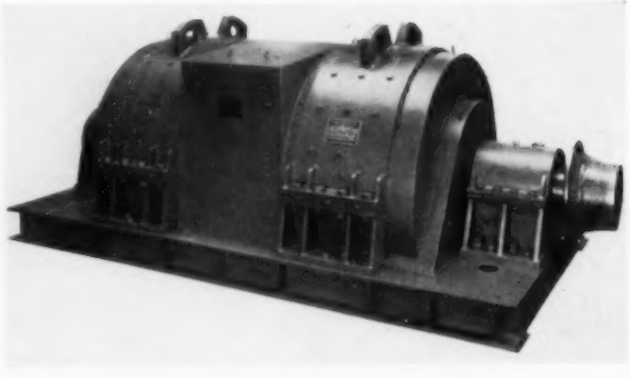
Ohmic drop—The use of ohmic drop compensation for high speed, cold strip mills has been in use for a considerable period of time. The back emf of the motor, hence the motor speed, differs from the voltage at the motor terminals by an amount equal to the IR drop. In order to hold proper speed relationship between the motors of the various stands during acceleration, it is necessary to correct the voltage at the terminals of each motor to compensate for the IR drop.

Here again, proper attention to the motor design can make the control problem simpler. Low values of IR drop are desirable, but of perhaps more importance is to have the proper matching of values for the various stands. It is virtually impossible to get perfect matching, but care in design can usually achieve a satisfactory approximation. The basic data given in Figure 3 is of material assistance in handling this problem.

Steady-state speed regulation — The steady-state speed regulation requirement is related to the ohmic drop and the requirement of matching steady-state and transient characteristics. It is desirable to have the proper matching between stands and to have the speed regulation very nearly equal to the IR drop. This is the same problem as for tandem tube and rod mills, and it is approached in the same manner.

Several means for controlling the speed regulations are employed. It is not normally advisable to attempt to adjust by means of brush position. Motors of this class require careful adjustment for best commutation, and little change in brush position can normally be tolerated. For reasons which stem from the basic nature

Figure 6 — The double armature d-c motor shown has covers arranged for forced ventilation.



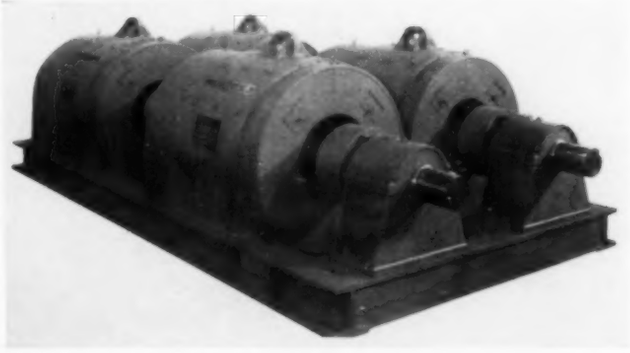
of commutation, a slight amount of differential compounding from the armature winding is usually present. A compensating amount of cumulative compounding must then be added. This can take the form of a conventional series field or of an auxiliary shunt field which is connected across the commutating field and thus has characteristics similar to a series field.

These conventional devices have a position in the magnetic circuit which is appreciably different from the magnetic force which is to be balanced. The leakage paths for flux are quite different, hence as might be expected a good balance cannot be achieved for all values of machine flux and speed. The use of an offset pole face winding, as illustrated in Figure 8, has proven to be a material improvement. Here the compounding is obtained by shifting the axis of the pole face winding, so that a small portion of the ampere turns effectively acts along the center line of the main flux axis. The compounding ampere turns so obtained are distributed in very nearly the same manner as the ampere turns to be compensated from the armature winding. Further the two opposing forces are in essentially the same position of the magnetic circuit. Here very close matching for all values of flux and speed can be obtained, and quite satisfactory results have been demonstrated.

The offset pole face winding is not an adjustable device, but rather a definite amount of compounding is built into the machine. It is not practical to attempt to do the adjustment job with this alone, so one of the conventional devices is normally used for final test adjustment. In the case of double armature motors, cross connected series fields are frequently used, and adjustment is obtained by shunting one of the fields of each motor. In other cases the auxiliary shunt field may be used, and adjustment is obtained through the use of an adjustable series resistor. In a typical case 80 per cent of the compensating ampere turns will come from the offset pole face winding and the remaining 20 per cent will be provided by the adjustable, conventional device.

Transient and steady-state characteristics — If the motor is to be properly controlled for the various operations of the mill, the desirable condition is that the motor flux be determined by the field excitation alone. In the common shunt wound motor the flux changes slightly not only with the load current but also with the rate of change of load current and with change in speed. Compensation to minimize changes with load and speed are discussed above. Fortunately, the same devices and adjustment serve well to keep flux changes resulting from rapid changes in load small.

Figure 7 — This arrangement of a double armature twin drive d-c motor is used to drive the last stand of a tandem cold strip mill.



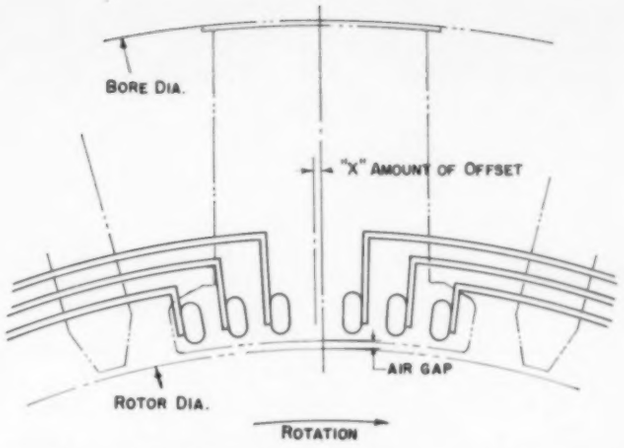


Figure 8 — Sketch shows offset pole face winding arranged for accumulative compounding for motor operation.

Conventional compounding devices, such as the series field, have been found to respond at a different rate than the compounding effect of armature reaction, which they are designed to compensate. Again it is the wide difference in magnetic leakage path which is largely responsible, and the offset pole face winding more accurately matches in every detail the compounding effect of armature reaction, and its use has well demonstrated its value. This device has been in use since 1933. Continued advances in the application of d-c machines to more difficult problems has increased its use, and improved understanding of d-c machine performance has made it an increasingly effective tool.

Individual generators for each stand — As higher speed tandem mills developed, the need for IR drop compensation became more important. This improvement was first accomplished through the use of line boosters. Each motor was connected to the generator bus through a booster generator. The booster was capable of supplying a voltage to compensate for the IR drop in the motor, and was regulated to supply a voltage proportional to the motor load current. This scheme had the disadvantage of requiring additional rotating machines with current capacity and commutator size comparable to the main motors.

Modern practice is to provide for IR drop compensation by the use of individual generator drive and by suitable control of the generator excitation. This has the obvious advantage of eliminating the line booster. This development has been primarily one of control, but as is usually the case proper attention to the design of the main machine and an appreciation of the control problem on the part of the motor designer can contribute much to the successful performance of the system.

In this case accurate matching of certain generator characteristics is desirable. One element in the control acts to raise the voltage on all motors simultaneously to accelerate the mill. Another element acts to correct the voltage at the motor terminals for the IR drop in the motor. Both of these elements produce

changes by changing the field excitation of the generators. The first element acts to change all generators uniformly. Obviously for this operation it is desirable that the generators have uniform no load saturation curves and regulation curves. Since the generators are usually of different rating and design, duplication of no load saturation becomes something of a problem for the designer. Sufficient matching can usually be obtained without provision for test adjustment other than change of air gap; however, better uniformity of magnetic characteristics of steel would be helpful.

Since fast acceleration is required, it follows that a suitable balance of the field time constants is also desirable for the various generators. This is required to get the same *rate* of voltage build-up. Fortunately, this turns out to be a simple problem. The well known differential equation is

$$\frac{d}{dt}\left(\frac{PN\phi}{10^8}\right)=E-iR, \qquad (4)$$

where P is number of poles connected in series, N is number of turns per pole, ϕ is lines of flux per pole, E is volts applied to the shunt field, i is shunt field amps, and R is the ohms resistance of the field. Since main field flux and generator voltage are proportional, then:

$$V=\frac{V_o}{\phi_o}\,\phi\,, \qquad (5)$$

where V is the terminal volts, and the zero subscript refers to rated values. Equations (4) and (5) can be combined to obtain:

$$\frac{dV}{dt}=\frac{(E-iR)}{\left(\frac{PN\phi_o}{10^8V_o}\right)} \qquad (6)$$

This means that if the terms $(E-iR)$ and $\left(\frac{P\ \phi_o}{10^8V_o}\right)$ are equal for two machines, then the rate of change of the terminal voltage with respect to time is the same. The term $\left(\frac{PN\phi_o}{10^8V_o}\right)$ can readily be made the same for all generators by adjusting the number of turns, N; and this term is fortunately independent of the amount of saturation or field current. The adjustment to get equal values of (E—iR) can readily be accomplished by adjusting the external resistance in the field circuit. The field voltage, E, is kept equal by the control circuit, hence it is only necessary to consider the adjustment of iR.

FAST REVERSING APPLICATIONS

Developments of control devices, with a very important contribution from rotating regulators, during recent years, has greatly improved the operation of fast reversing application such as slabbing and blooming mills. This has created some new problems for the designer of the d-c machines, and has lent new emphasis to some of our older ones. Extended use of the "twin drive" has contributed much to the art, and has also introduced new design problems which are primarily mechanical in nature.

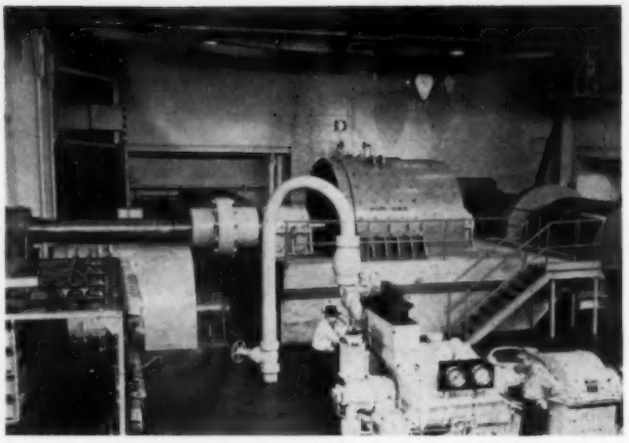


Figure 9 — Shown in the photograph is the arrangement of 6000-hp, twin drive, d-c motors for slabbing mill. Note how the frame size establishes the position of the second motor.

In the photograph of Figure 9, is shown a typical installation of twin drive motors. The lower elevation motor is located nearer to the mill and is connected to the lower roll of the mill. The upper elevation motor is located further away from the mill to clear the lower motor, and is connected to the mill spindle by a shaft section which just clears the frame of the lower motor. The spacing of the upper and lower shafts is thus determined largely by the frame diameter of the motor. Usually it is desirable to keep this spacing as small as possible, so the smallest possible frame diameter is indicated.

Double thrust bearing—One problem which has developed with the twin drive is that the motor is required to take an oscillating thrust. This thrust comes from the universal joints used with the mill spindle. The thrust may be in either direction depending on the position of the universal, and there is a tendency for the thrust to go through a complete reversal during each revolution. Due to the greater spindle angle, the upper motor received the more severe thrust. Thus, thrust must be taken in both directions, and the rapid reversals of thrust cause the shaft collar to strike the thrust bearing repeatedly in each direction with a sharp impact. Actually the thrust force from the universal is not large. However, in accelerating the mass of the motor armature through a clearance distance of $\frac{1}{8}$ to $\frac{1}{4}$ inch, a considerable amount of energy is stored, and this energy must be rapidly absorbed as the thrust bearing makes contact. The action is much the same as a massive battering ram.

Two methods of reducing the severity of this action suggest themselves. First, cushioning of the thrust bearing can be provided to allow an appreciable distance for stopping the moving armature, thus reducing the peak force on the bearing and pedestal. This could take the nature of either a spring or hydraulic support for the thrust bearing. Second, the distance

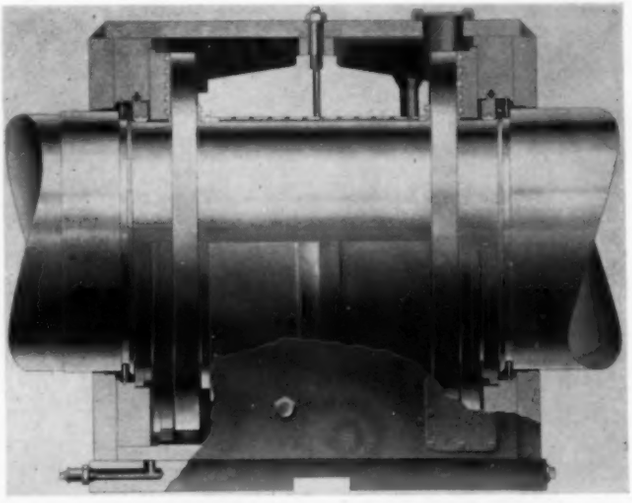
through which the armature is allowed to move freely and be accelerated can be limited to a small value. In this case the axial velocity of the armature is limited and the impact force reduced.

A design which makes primary use of the second principle and secondary use of the first principle is illustrated in Figure 10. Earlier practice was to use a one-way thrust bearing at each end of the motor. In order to allow for thermal expansion and contraction of the shaft and still maintain running clearance, it was necessary to have free axial movement of the shaft of the order of ¼ in. in the limiting case. The design shown in Figure 10, incorporates both thrust bearings in one pedestal, separated only by the journal bearing, and permits holding the free movement to a maximum of $\frac{1}{32}$-in. Thus, the axial velocity of the armature is kept to a low value, and the resulting battering ram action is limited. A small amount of cushioning action is also inherent in this design. The thrust collars run in oil, hence a heavy oil film is maintained and provides some cushioning action. Also, the mechanical parts make a further contribution since small deflections result from the application of the thrust force. A large number of applications of this design have proven quite successful. Among its assets are simplicity, ruggedness, and freedom from gadgets.

Other familiar and well-proven features are maintained in the design. The journal bearing is the spherical seat, self-aligning type. A disc, in this case one of the thrust collars, is used to supply oil to the journal bearing. The disc runs in oil and carries oil on its periphery up to the top of the bearing where it is removed by a scraper and directed into the journal bearing. This is not only a more positive method of feeding oil to the bearing than the conventional oil ring, but it is also more readily adapted for supplying a more generous quantity of oil.

Duplication of motors—The mechanical arrangement of the twin drive makes possible the duplication of the upper and lower motors. Through cooperation with the mill builder it has always proven possible to use the same design of coupling for the two motors. This dictates the coupling design for the extra length of shaft for the upper motor. It has been necessary to use a spigot fit and an accurately machined coupling face for the upper motor for the purpose of providing means for an accurate alignment check. This has precluded the use of cross keys which are cast integral with the coupling. Although not needed, it has proven practical to include the spigot fit for the lower motor in order to provide for interchangeability. It is usually necessary to split the pedestal cap for the drive end bearing of the lower motor to permit access for maintenance, since this bearing is underneath the bridge which supports the upper bearing. Parts and assemblies are still interchangeable.

Figure 10 — Cut-away view shows design of double thrust bearing with spherical seat and disc lubrication.



Treatment of joints — Fast reversal and the shock nature of loading of motors of this type dictate great care in design and assembly of the various rotor parts. All joints which transmit torque, such as coupling to shaft and shaft to spider, are made with a heavy, shrink fit and furnished with carefully fitted tangential keys of generous design. An interference fit is obtained at the dovetail joint between the spider and punchings by assembling the dovetail of the punching in a crimped condition and by applying pressure to straighten the crimp after assembly. The rotor flanges are keyed directly to the dovetail heads, which has gotten away from the use of heavy through bolts with the attendant vibration problem.

Insulation and electrical connections—Since such an installation as this represents a large and vital element of a mill, the use of best possible materials and techniques are employed to insure long life of insulation and electrical connections for both motors and generators. Insulation materials are now entirely of the Class B type for the rotor. Hand laid mica tape and mica sheet are used for both the turn and coil insulation. In addition, a mica separator is used between turns. The coil is finally covered with glass tape, treated with high grade varnish and moulded to slot size. As further protection during assembly and to provide for thermal expansion a slot liner of treated glass cloth is used. Flange and binding band insulation utilizes mica sheet and glass cloth. Alertness to new and better insulation materials is continually maintained. New materials are now becoming available which offer some encouragement for their use. However, machines of this type are hardly the place to experiment, and such materials will undergo exhaustive tests before they are applied.

All electrical connections are made with high temperature silver solder, now commonly called brazing. This represents a decided improvement over the use of low temperature tin or tin-lead solders. The brazing process is easier to control and insure good workmanship. The resulting joint can be operated safely at a much higher temperature, so that the limit is now imposed by other considerations such as insulation temperature. Also, the brazed joint is a marked improvement mechanically, and shows much greater ability to stand stress without aging at operating temperature.

Commutation—Since a minimum motor diameter is required both for minimum shaft spacing and for low armature inertia, commutation factors become a design limitation, even though the motors are in the slow speed class. The generators are high speed ma-

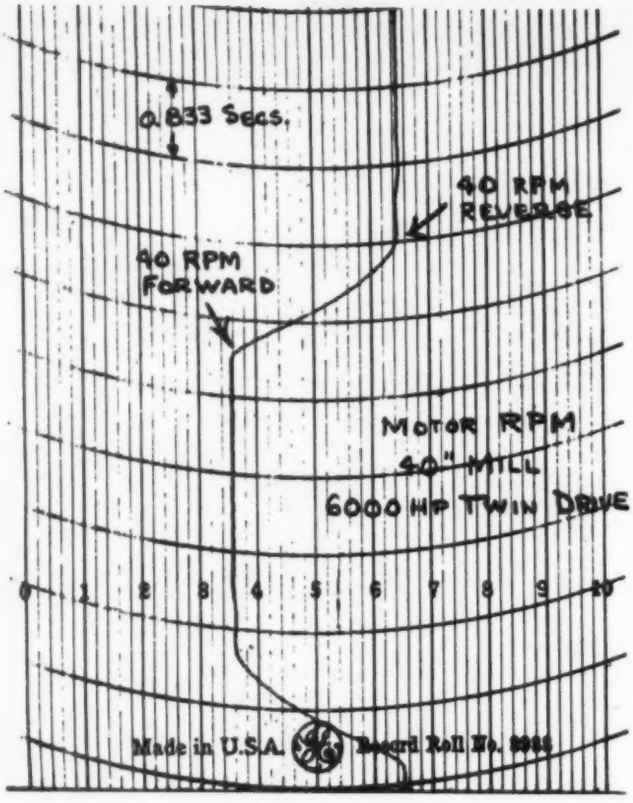
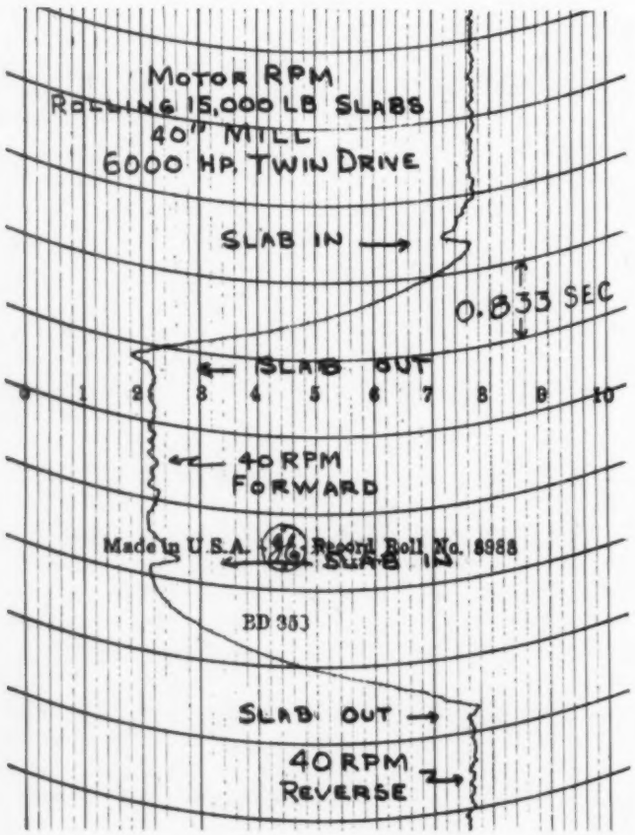


Figure 11 — Photo-electric recorder chart gives motor speed during reversal for 6000-hp twin drive.

Figure 12 — Photo-electric recorder chart gives motor speed during rolling of 15,000-lb slab for 6000-hp twin drive.



chines, so commutation factors are also limiting. Although not greatly different for the motors and generators, the commutation problem has been a little more acute for the generators.

Successful commutation depends on a large number of factors involving both design and operation. Misleading results usually are obtained when only one factor is considered. A partial list of influencing factors for steady loads is: reactance voltage, perfection of compensation for reactance voltage by not only the right value of commutating pole flux but also the right distribution of flux, freedom from saturation in magnetic circuit of the commutation pole, adequate neutral space between main pole tips, brush characteristics, manner in which the brush rides the commutator, type of armature winding, etc.

For transient loads the same factors are important, and it is also important for the rate of change of commutating field flux to follow accurately the rate of change of current, so that at any instant the two maintain a proper balance. It is important to note that first the machine must commutate well for steady loads, and that this is only one added factor. If more margin is provided for steady load commutation, more variation in the proper flux balance can be tolerated. As is usually the case with engineering problems this transient requirement can be met in different ways. One method using a laminated magnet frame, has been described in the paper of reference [4]. Another approach is to build good margins for steady load commutation into the machine and to keep the total flux in the commutating pole down to a value consistent with what can be transmitted through the surface layer, "skin effect", of the solid magnet frame. Adequate margins can be maintained through ingenious design and by using a larger machine. Much can be accomplished in keeping the commutating pole flux low by proper location of the pole face and commutating field windings.

In order to demonstrate the validity of this analysis, three d-c generators were built as duplicate designs except that the first had a solid frame, the second a frame with $\frac{3}{16}$ in. thick laminations, and the third a frame with 0.025 in. laminations. The punchings were enameled and assembled so that no short circuiting loop due to rivets, etc., was present. The basic design was such as to give good commutation margin for steady load and to keep the commutating pole flux low. These machines have now been in service for several months supplying power to twin drive reversing motors. Commutation on all machines is good, and it is not possible to detect any real difference in commutation performance. The designer then has at least two choices in this case in providing the user with good commutation performance; and basically it is performance, not a laminated frame, which the user really wants.

Reversal time — One of the most important performance characteristics is speed of reversal. Through improvements in machine design illustrated here as well as major improvements in control, good progress has been made in reducing the reversal time. The chart of Figure 11 illustrates performance obtained for reversal of a 6000-hp, 40-rpm base speed, twin

drive. This chart shows motor speed taken with a photo-electric recorder during a reversal from base to base speed. Time of reversal is 1.25 seconds. The chart of Figure 12 shows performance while rolling a 15,000-lb slab. Idle time between passes has been cut to approximately 1.5 seconds. Possibilities for further improvement are being studied, and no doubt can be realized if there is a real demand.

Short-circuit currents—Reliable and readily accessible data for predicting short-circuit currents in d-c machines and systems has not been generally available until recently. Recent papers in the technical press, references (5), (6), (7), and (8), represent real contributions along this line. The papers by Linville, Linville and Ward, give a method for predicting the short-circuit current from design constants of the machine. The paper by MacClinton, Brancato and Panoff presents test short-circuit data for several individual machines and for a system involving several d-c machines, and compares results with calculated data.

The paper by Darling constitutes a report for the D-C Machines Sub-committee of the AIEE, and represents a contribution from many individuals, including data submitted by several manufacturers. The data is correlated and plotted as to type and size of the machine. It gives in readily usable form a chart for estimating the maximum short-circuit current for a machine from nameplate data. Similar information is now being collected for armature circuit inductance, which will permit the same sort of estimate for the rate of rise of armature current on short-circuit. This information should greatly facilitate the proper selection of circuit breakers and other protective equipment and should provide a better basis for designing bus structures. This project would undoubtedly move more rapidly toward completion if users of d-c machines, such as are represented in the Association of Iron and Steel Engineers, would exhibit an active and urgent interest.

BIBLIOGRAPHY

1. *"Speed Transients of D-C Rolling Mill Motors"*—T. M. Linville and L. A. Umansky, AIEE Transactions, Vol. 54, 1935, pp. 387-94.

2. *"Speed Stability of Motors for Continuous Mills"*—F. E. Crever and T. M. Linville, Proceedings of Association of Iron and Steel Engineers, 1947, p 318.

3. *"An Extension of Impact Speed-Drop Analysis"*—F. E. Crever, AIEE Transactions, Vol. 66, 1947, pp. 191-96.

4. *"Improved D-C Generators for Reversing Mills"*—Clarence Lynn and W. H. Burr, Proceedings of Association of Iron and Steel Engineers, 1948, pp. 113-117.

5. *"Current and Torque of D-C Machines on Short-Circuit"*—T. M. Linville, AIEE Transactions, Vol. 65, pp. 956-65.

6. *"Solid Short-Circuits of D-C Motors and Generators"*—T. M. Linville and H. C. Ward, AIEE Transactions, Vol. 68, 1949, pp. 119-23.

7. *"Transient Characteristics of D-C Motors and Generators"*—A. T. McClinton, E. L. Brancato and Robert Panoff; AIEE Transactions, September, 1949.

8. *"Maximum Short-Circuit Current of D-C Motors and Generators"*—A. G. Darling, AIEE Transactions, 1950.

STEEL FOR WESTERN NEEDS*

▲ ON April 12, 1882 the first bessemer steel ever produced west of the Missouri River was rolled at the Pueblo plant rail mill into 30-lb rails for the Denver and Rio Grande Railroad. During the years between 1892 and 1904, the Colorado Fuel and Iron Co. constructed additional blast furnaces, new open hearth furnaces, a new blooming mill and rail mill, a new bar mill, a new rod and wire mill, a new nail mill, and a new structural mill.

On the west coast, rolling mill operations were pioneered by the Pacific Rolling Mill Co. in 1868. Expansion in steel production continued on the west coast for the production of steel castings, steel ingots, billets, bars, structurals, wire products, sheets and tin plate. In recent years the growth in the demand for flat rolled steel products in the form of sheet and tin plate prompted the installation of the first cold reduction sheet and tin plate mill west of the Mississippi River at the Pittsburg works of the Columbia Steel Co. Also, since World War II, the Geneva Steel Co. at Geneva, Utah, has converted its plate mill to produce both plate and hot rolled coils; other western steel producers have added capacity to produce pipe and a variety of other products to round out their product lines.

Thus, the development of the railroad industry in the west gave western steel mills an opportunity to provide such steel products as rails, track spikes, track bolts, tie plates, and joint bars. The Colorado Fuel and Iron Corp. is today the largest and only western producer of rails, and, in combination with other western producers, supplies track accessories for western railroad needs.

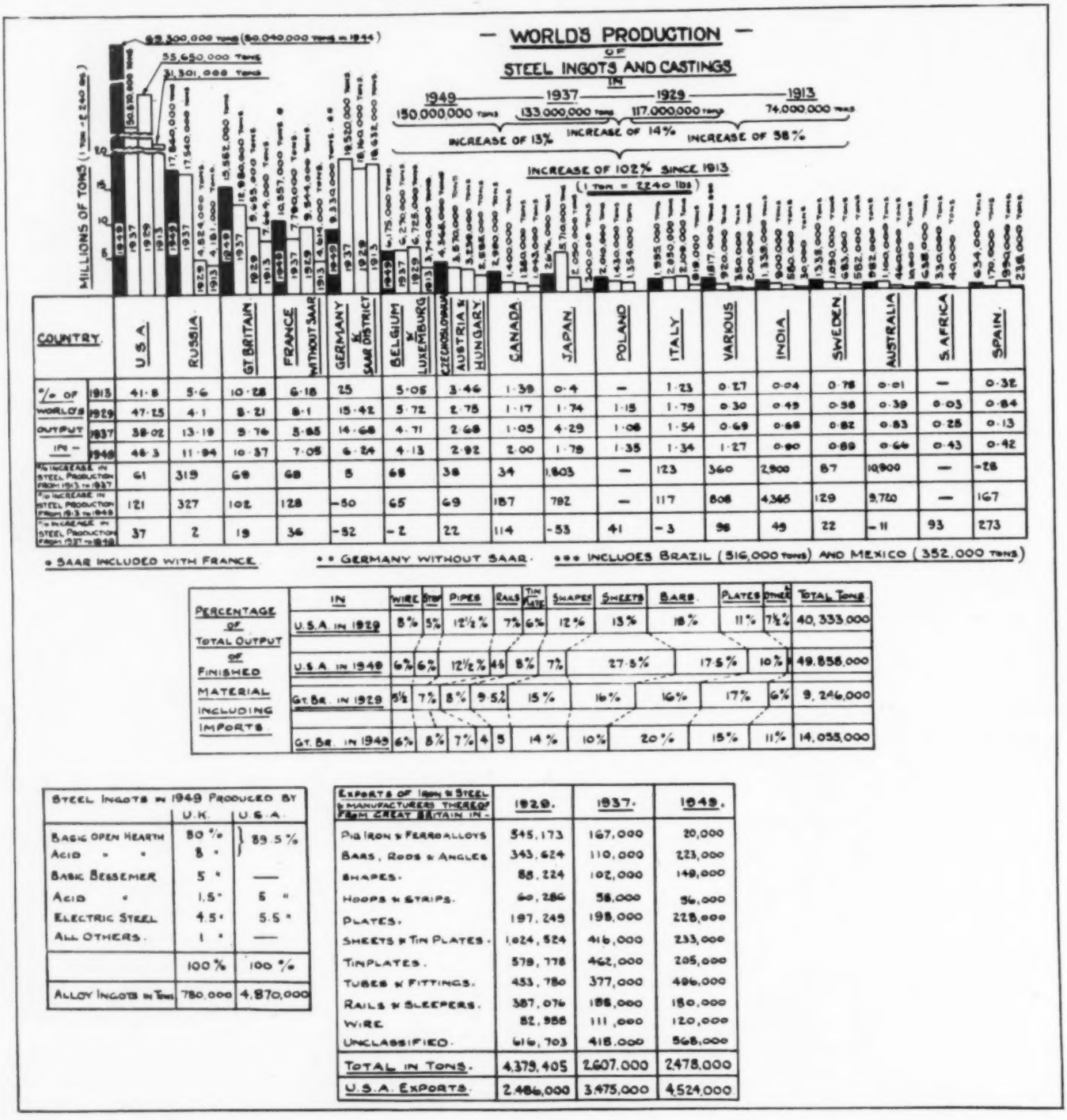
The agricultural and livestock industry brought new product needs to western steel mills in the form of baling wire, various types of field and farm fence, fence posts; poultry netting and barbed wire, welded wire fabric, and other wire items. Rolled steel products, such as small structural shapes, angles, bars, sheets and tin plate, and grader blades, have also been needed in the manufacture of various farm implements, wind mills, pumps, tin cans and other equipment by this great industry which serves the west and the nation.

The petroleum industry has provided western steel mills with a large market. The Bethlehem Pacific Coast Steel Corp. is the largest fabricator of oil well equipment for western petroleum needs.

American Iron and Steel Institute reports that the most significant expansion has taken place in western states. California has become one of the first ten steel producers in the country. Western steelmaking capacity has increased from about 2 million tons in 1940 to over 5½ million tons in 1950.

*Abstracted from paper of same title presented by John Zadra, Assistant Chief Metallurgist, the Colorado Fuel and Iron Corp., at San Francisco Regional Technical Meeting of AISI, November 10, 1950.

U. S. PRODUCES ALMOST HALF OF WORLD'S STEEL



COUNTRY		U.S.A.	RUSSIA	GT BRITAIN	FRANCE	GERMANY WITHOUT SAAR	BELGIUM & LUXEMBURG	CZECHOSLOVAKIA	AUSTRIA & HUNGARY	CANADA	JAPAN	POLAND	ITALY	VARIOUS	INDIA	SWEDEN	AUSTRALIA	S. AFRICA	SPAIN
% OF WORLD'S OUTPUT IN —	1913	41·8	5·6	10·28	6·18	25	5·05	3·46	1·39	0·4	—	1·23	0·27	0·04	0·78	0·01	—	0·32	
	1929	47·25	4·1	8·21	8·1	15·42	5·72	2·75	1·17	1·74	1·15	1·79	0·30	0·49	0·58	0·39	0·03	0·84	
	1937	38·02	13·19	9·76	5·85	14·68	4·71	2·68	1·05	4·29	1·08	1·54	0·69	0·68	0·82	0·83	0·28	0·13	
	1949	46·3	11·94	10·37	7·05	6·24	4·13	2·92	2·00	1·78	1·35	1·34	1·27	0·90	0·89	0·66	0·43	0·42	
% INCREASE IN STEEL PRODUCTION FROM 1913 TO 1937		61	319	69	68	5	68	38	34	1603	—	123	360	2900	87	10900	—	-28	
% INCREASE IN STEEL PRODUCTION FROM 1913 TO 1949		121	327	102	128	-50	65	69	187	782	—	117	808	4365	129	9720	—	167	
% INCREASE IN STEEL PRODUCTION FROM 1937 TO 1949		37	2	19	36	-52	-2	22	114	-53	41	-3	98	49	22	-11	93	273	

* SAAR INCLUDED WITH FRANCE. ** GERMANY WITHOUT SAAR. *** INCLUDES BRAZIL (516,000 TONS) AND MEXICO (352,000 TONS)

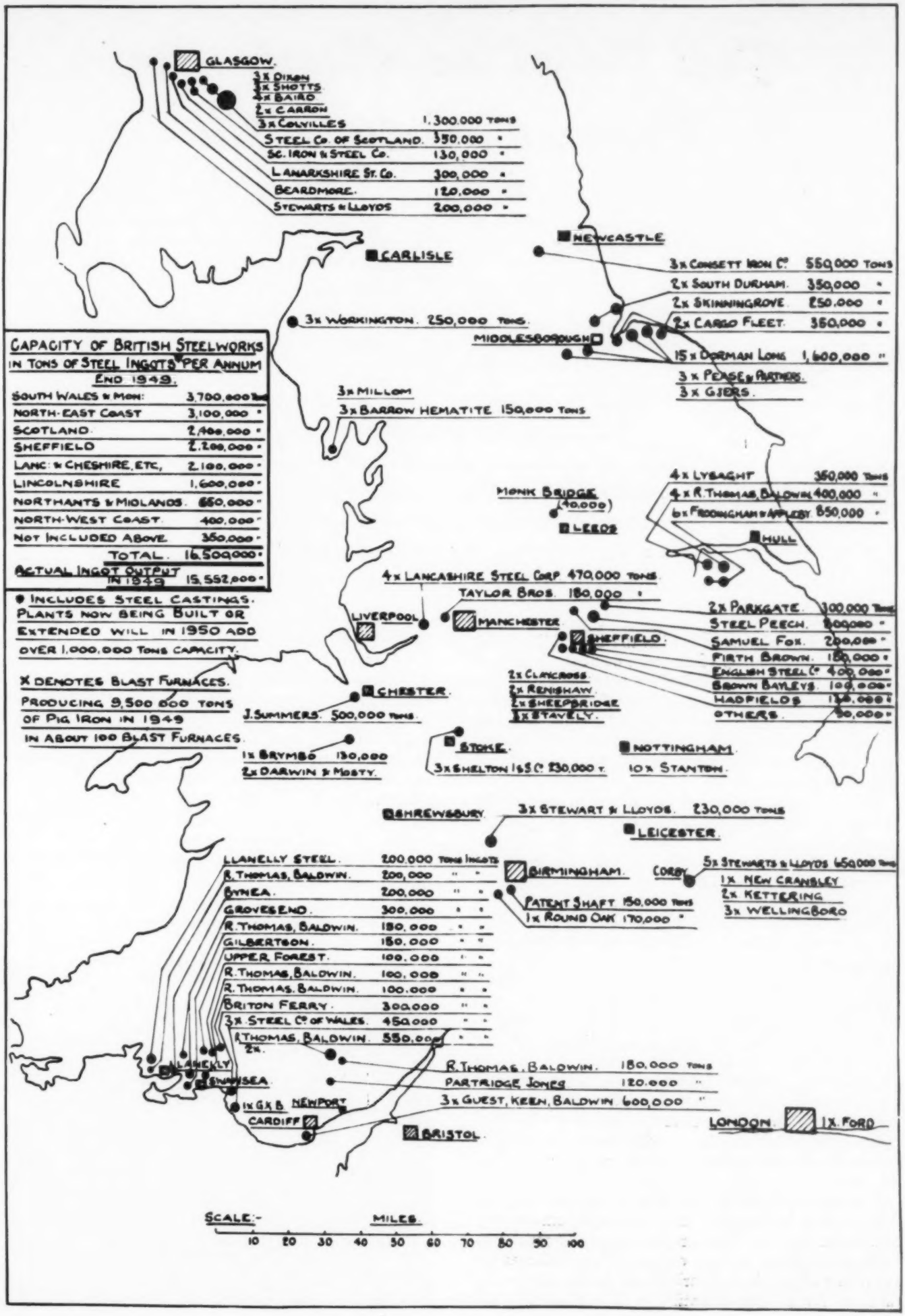
PERCENTAGE OF TOTAL OUTPUT OF FINISHED MATERIAL INCLUDING IMPORTS	WIRE	STRIP	PIPES	RAILS	TIN PLATE	SHAPES	SHEETS	BARS	PLATES	OTHER	TOTAL TONS
U.S.A. IN 1929	8%	5%	12½%	7%	6%	12%	13%	18%	11%	7½%	40,333,000
U.S.A. IN 1949	6%	6%	12½%	4	5	7%	27·5%		17·5%	10%	49,858,000
GT. BR. IN 1929	5½	7%	8%	9·5		15%	16%	16%	17%	6%	9,246,000
GT. BR. IN 1949	6%	8%	7%	4	5	14%	10%	20%	15%	11%	14,055,000

STEEL INGOTS IN 1949 PRODUCED BY	U.K.	U.S.A.
BASIC OPEN HEARTH	80 %	89·5 %
ACID " "	8 "	
BASIC BESSEMER	5 "	—
ACID "	1·5 "	5 "
ELECTRIC STEEL	4·5 "	5·5 "
ALL OTHERS.	1 "	—
	100 %	100 %
ALLOY INGOTS IN TONS	780,000	4,870,000

EXPORTS OF IRON & STEEL & MANUFACTURES THEREOF FROM GREAT BRITAIN IN —	1920.	1937.	1949.
PIG IRON & FERROALLOYS	545,173	167,000	20,000
BARS, RODS & ANGLES	343,624	110,000	223,000
SHAPES.	88,224	102,000	149,000
HOOPS & STRIPS.	60,286	58,000	56,000
PLATES.	197,249	198,000	228,000
SHEETS & TIN PLATES.	1,024,524	416,000	233,000
TINPLATES.	578,778	462,000	285,000
TUBES & FITTINGS.	453,780	377,000	496,000
RAILS & SLEEPERS.	387,076	188,000	150,000
WIRE	82,988	111,000	120,000
UNCLASSIFIED.	616,703	418,000	568,000
TOTAL IN TONS.	4,379,405	2,607,000	2,478,000
U.S.A. EXPORTS.	2,486,000	3,475,000	4,524,000

▲ A vital factor in the strength of any nation is its steel capacity. Important also in the economy is the type of steel which is produced. These tables give a graphic picture of the source on which the economic strength of the great powers is based. The chart above gives data on tonnage and production distribution on a worldwide scale, and that on the right gives detailed data for Great Britain. It should be carefully noted that all tonnages are gross tons (2240 lb). These charts have been published through the courtesy of the International Construction Co., Ltd., successors to Julian Kennedy, Sahlin & Co., Ltd. of London, England. Data is as of September 1, 1950.

Steel production for the world is about 150,000,000 tons, more than double that in 1913. Of this, almost one-half was produced in the United States. Of interest also is the large percentage of U. S. steel which is produced as sheets. This is a reflection of the automobiles and appliances which are such an important factor in the U. S. economy. A shift to this product will undoubtedly develop in other countries of the world, as their standard of living is raised to supply these items, now considered luxuries by most countries.


GLASGOW
3 x DIXON
3 x SHOTTS
4 x BAIRD
2 x CARRON
3 x COLVILLES 1,300,000 TONS
STEEL Co OF SCOTLAND 350,000 "
SC. IRON & STEEL Co. 130,000 "
L. ANARKSHIRE St. Co. 300,000 "
BEARDMORE 120,000 "
STEWARTS & LLOYDS 200,000 "
CARLISLE
NEWCASTLE
3 x CONSETT IRON Co 550,000 TONS
2 x SOUTH DURHAM 350,000 "
2 x SKINNINGROVE 250,000 "
2 x CARGO FLEET 350,000 "
15 x DORMAN LONG 1,600,000 "
3 x PEASE & PARTNERS
3 x GJERS
3 x WORKINGTON 250,000 TONS
MIDDLESBOROUGH
3 x MILLOM
3 x BARROW HEMATITE 150,000 TONS
CAPACITY OF BRITISH STEELWORKS
IN TONS OF STEEL INGOTS PER ANNUM
END 1949.
SOUTH WALES & MON: 3,700,000 Tons
NORTH-EAST COAST 3,100,000 "
SCOTLAND 2,400,000 "
SHEFFIELD 2,200,000 "
LANC. & CHESHIRE, ETC, 2,100,000 "
LINCOLNSHIRE 1,600,000 "
NORTHANTS & MIDLANDS 650,000 "
NORTH-WEST COAST 400,000 "
NOT INCLUDED ABOVE 350,000 "
TOTAL 16,500,000 "
ACTUAL INGOT OUTPUT IN 1949 15,552,000 "
• INCLUDES STEEL CASTINGS.
PLANTS NOW BEING BUILT OR EXTENDED WILL IN 1950 ADD OVER 1,000,000 TONS CAPACITY.
X DENOTES BLAST FURNACES.
PRODUCING 9,500 000 TONS OF PIG IRON IN 1949
IN ABOUT 100 BLAST FURNACES.
4 x LYBAGHT 350,000 TONS
4 x R. THOMAS, BALDWIN 400,000 "
6 x FREDINGHAM & APPLEBY 850,000 "
MONK BRIDGE (40,000)
LEEDS
HULL
4 x LANCASHIRE STEEL CORP 470,000 TONS
TAYLOR BROS. 180,000 "
LIVERPOOL
MANCHESTER
SHEFFIELD
2 x PARKGATE 300,000 Tons
STEEL PEECH 300,000 "
SAMUEL FOX 200,000 "
FIRTH BROWN 150,000 "
ENGLISH STEEL Co 400,000 "
BROWN BAYLEYS 100,000 "
HADFIELDS 150,000 "
OTHERS 50,000 "
2 x CLAYCROSS
2 x RENISHAW
2 x SHEEPBRIDGE
1 x STAVELY
CHESTER
J. SUMMERS 500,000 TONS
1 x BRYMBO 130,000
2 x DARWIN & MOSTY.
STOKE
3 x SHELTON I & S Co 230,000 T.
NOTTINGHAM
10 x STANTON
SHREWSBURY
3 x STEWART & LLOYDS 230,000 TONS
LEICESTER
LLANELLY STEEL 200,000 TONS INGOTS
R. THOMAS, BALDWIN 200,000 " "
BYNEA 200,000 " "
GROVESEND 300,000 " "
R. THOMAS, BALDWIN 180,000 " "
GILBERTSON 150,000 " "
UPPER FOREST 100,000 " "
R. THOMAS, BALDWIN 100,000 " "
R. THOMAS, BALDWIN 100,000 " "
BRITON FERRY 300,000 " "
3 x STEEL Co OF WALES 450,000 " "
R. THOMAS, BALDWIN 550,000 " "
2 x
BIRMINGHAM
PATENT SHAFT 150,000 TONS
1 x ROUND OAK 170,000 "
CORBY
5 x STEWARTS & LLOYDS 650,000 Tons
1 x NEW CRANSLEY
2 x KETTERING
3 x WELLINGBORO
R. THOMAS, BALDWIN 180,000 TONS
PARTRIDGE JONES 120,000 "
3 x GUEST, KEEN, BALDWIN 600,000 "
LLANELLY
SWANSEA
1 x G x B NEWPORT
CARDIFF
BRISTOL
LONDON
1 x FORD
SCALE:- MILES
10 20 30 40 50 60 70 80 90 100

Fuel Oil as an Absorbent in Recovery of Light Oil

By C. R. MONTGOMERY
Chief Chemist
By-Product Coke Dept.
Pittsburgh Steel Co.
Pittsburgh, Pa.

. . . . recent work has shown that fuel oil can be used as an absorbent with just as good recovery, cleanliness and quality as obtained with the usual wash oils, while saving money on the purchase price . . . .

▲ **THE** principal process used in the United States for the recovery of light oil from coke oven gas is that of absorption with a higher-boiling petroleum oil. This oil is usually termed "wash oil" by the industry. The light oils absorbed or washed from the gas are easily recovered from the wash oil by distillation. The petroleum oil, freed of its aromatic load, is then recirculated to absorb more light oil.

It is not the purpose of this paper to discuss the theory of this process nor the equipment necessary for its operation. For those interested in this particular field, we suggest the reading in the "Chemistry of Coal Utilization," edited by Lowery, chapter 28, "Light Oil From Coke Oven Gas," written by William L. Glowacki. A brief description of our equipment is given for those not familiar with this process or the recovery apparatus.

Coke oven gas produced in the ovens passes up through the oven free space, through the stand pipes, into the collecting main, through the suction main, to the primary coolers, through the exhauster, through the saturator, to the final cooler, and then to the light oil, or benzol, scrubbers. In Monessen, these scrubbers consist of two steel towers twelve feet in diameter and packed with four banks of steel spirals 8 ft 6 in. high. The second scrubber has an additional 1 ft bank of spirals placed above the sprays to act as a mist eliminator.

The continual search for a cheaper product to do as good a job, or better, plus steady pressure from the purchasing department, led our department to conduct a series of exploratory tests on possible substitutes for our rather high-priced absorbent oil. Let me emphasize that, as far as the operating men were concerned, they were well pleased with the oil then in use, because it had been giving good results, without any offsetting difficulties, for the eight years the plant had been operating. They had experienced no tendency towards increased pressure drops through the scrubbers, no undue build-up of sludges in the pumping tanks or lines, and only a normal amount of cleaning of the final heater. For these reasons, the investigation was no doubt slower in gaining momentum than if our operators had been experiencing difficulties in their operations.

Coke oven gas is a mixture of aromatic and parafinic

Figure 1 — Wash oil cooling coil showing water distribution through spray nozzles over the cast iron cooling sections.

hydrocarbons, saturated and unsaturated, as well as of inorganic gases. Most of the difficulties encountered in recovering the desirable light oil come in the absorption from the gas, at the same time, of small amounts of unsaturated organic hydrocarbons which tend to polymerize and oxidize into compounds of higher molecular weight and higher boiling point. Upon steam distillation to recover the light oil from the wash oil-light oil mixture, termed benzolized oil, not all of these rather complicated compounds volatilize, as their vapor pressures are as low, or lower than, the wash oil, and they remain in the wash oil and are recirculated through the system. The tendency is for these compounds to react with others of the same nature, tending to become larger in molecular weight and size until they entrap themselves with other compounds, and form gums, sludge, or mucks.

For this reason, one of the primary factors in picking a wash oil is to obtain one which in itself is not easily oxidized nor subject to easily-formed addicts. Furthermore, it must have a vapor pressure low enough to insure a minimum loss in the scrubbers and wash oil still; a specific gravity low enough that it will quickly and easily separate from water; and a viscosity low enough to permit ease in pumping and good distribution in the scrubbers. Other properties which are guides in selection of wash oil are: pour point, absorptive capacity, tendency to emulsify, chemical nature parafinic, or naphthenic, etc.

A typical specification for a petroleum wash oil is (quoting from "Coal Coke & Coal Chemicals" by Wilson and Wells) is as follows:

Specific gravity @ 15.5/15.5 C (60 F)—Generally between 0.855 and 0.880 but not over 0.880.

Flash point (closed cup tester)—138 C (280 F) or higher.

Viscosity (saybolt universal)—Not over 65 sec at 38 C (100 F).

Cloud test—Not over 1 C (30 F).

Emulsification with water—95 cc should separate in 10 minutes when 100 cc of water and sample are shaken together for 30 sec at 21 C (70 F).

Distillation range—Not more than 5 per cent under 250 C (482 F) and not less than 90 per cent under 370 C (698 F).

Olefins—Not more than 15 per cent when tested by shaking 5 cc of sample with 10 cc of 100 per cent sulphuric acid for 30 minutes at ice temperature in a 30 per cent Babcock bottle.

Decomposition test—As low as possible, preferably not over 2.1 per cent by weight, when 200 grams of sample are heated at 140 to 145 C (284 to 293 F) for 5 days in air.

Steam distillation—Not more than 10 cc of oil are to come over in the distillate when 1000 cc of wash oil are steam distilled until 1000 cc of condensed steam have been collected, and no permanent emulsion of oil and water to remain in the still.

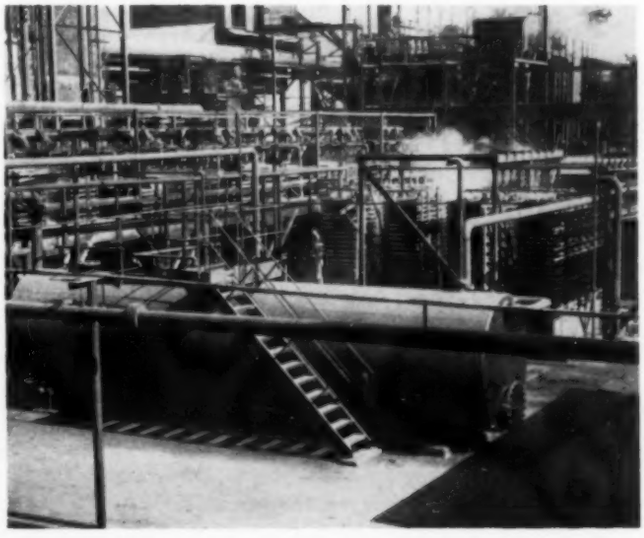
The specification just quoted is not the one that our plant was using at the time of this investigation. We were purchasing our oils on a specification recommended by the Koppers Co., which had been developed prior to 1933 by their laboratories at the Mellon Institute. The more important difference in these two specifications were in olefin content and distillation range. The former is given as not over 8 per cent, and the latter, not over 1 per cent boiling below 300 C and not less than 90 per cent under 370 C, in these specifications.

Quoting from a former supplier, "Perhaps the most important single characteristic of wash oil is the control of the boiling range. A narrow range cut of this type is difficult to make, but in our opinion is required for satisfactory operation." The range spoken of is 287-358 C (550-650F).

If a wash oil meets the above laboratory test, the chances are small, indeed, that trouble will be encountered due to the oil. It must, however, still pass the critical test of use in the plant equipment. It is a known fact, moreover, that two plants with similar equipment using the same oil will not necessarily get the same results.

A meeting was arranged with our technical men, representatives of the purchasing department, operators, and an outside refinery man who could advise as to possible fractions, alone or combined, that we might use if we decided that replacement of the high-priced oil by one of lower price seemed of sufficient merit to warrant further investigation. We discussed the theory of absorption, compared petroleum refinery practices with our own, and finally carefully reviewed the wash oil specifications in use by our plant. These specifications had been obtained prior to the erection of our plant and were in general use by the industry. The conclusions reached from this study were that an oil which met the specifications, as set up, would be a good wash oil, but that perhaps the specifications were too narrow, and excluded oils which could be used to advantage; if operators were to get into trouble using the oil meeting these specifications, it would most certainly not be the fault of the oil, and this was perhaps the primary reason for setting up such close specifications. They would insure a usable oil, one that would meet the varied conditions encountered in by-product plants throughout the country, with rather wide variations in types of carbonizing and recovery equipment. But perhaps individual plants could operate on oil made

Figure 2 — Wash oil circulating tank with cooling coils in background.



to less rigid specifications. It was agreed that the possibilities merited consideration.

In reviewing the specifications, we noted one thing in particular; we were buying an oil with a range of from 550-650 F; or 290-350 C. The Koppers specifications were 89 per cent between 300 and 370 C. The Wilson and Wells specification called for 85 per cent between 250 and 370 C. Obviously, if we were paying a premium for the first product, it was quite in order to reconsider our buying practice.

As a first step, samples of a number of oils were obtained. The one selected met the principal points of the previous specifications. The distillation range is within the specified range. The olefins are well within the above specification, as are the decomposition and the emulsification tests. The question then arises: wherein does new oil vary from the special-cut, high-priced oil used before? Frankly, it varies very little except that the boiling range is wider, the cloud point higher, and the viscosity and specific gravity lower than in the oil previously used.

COMPARISON

Former oil (Special absorbent oil)		Present oil (No. 3 gas oil)
0.8364	Specific gravity	0.8351
282 C	Distillation FD	230 C
294 C	5	278 C
322 C	60	324 C
346 C	90	347 C
352 C	95	356 C
357 C	dry	392 C
26.0 C	Pour point	37.0 C
	Specific viscosity	
54.5 sec	SU @ 38 C	44.8 sec
6.8 per cent	Olefins	7.0 per cent
.13 per cent	Decomposition	0.096 per cent
90 sec	Emulsification	84 sec

What has been the effect on light oil and production? A comparison of the years 1949 and 1950 reveals:

Light oil, per cent (by weight) of dry coal charged

	1950 (1)	1949
January (2)	1.06	1.01
April	1.22	1.22
May	1.16	1.20
Average	1.146	1.143

1.146 per cent by weight — 3.16 gallons per ton
1.143 per cent by weight — 3.15 gallons per ton

(1) Since December 1949 our light oil has been dry at 115 C, while prior to this date the dry point was 120 C. This means an actual light oil yield for 1950 higher than the above figures show.

(2) Only these months could be used as comparison, because our coking time, per cent of low volatile coal used, etc., were the same only, in these months of these two years.

The Btu value of our gas after the scrubbers has not increased, as it would if our scrubbing was less efficient.

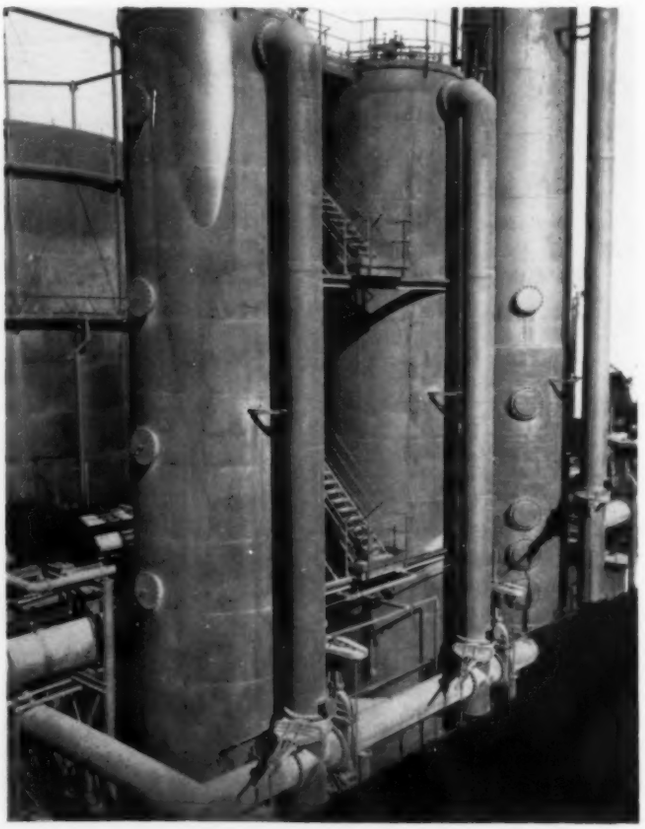
We never have had a great deal of shut-down time which could be charged to dirt in our wash oil system. Our final heater is our greatest source of trouble, due to build-up within the tubes. It required cleaning on the average of once a month, prior to changing our wash oil. Since that time, we have been cleaning it once every two months. Our wash oil system is equipped with an old-style wash oil purifier, and has done an excellent job of maintaining our wash oil muck low enough to prevent excessive cleaning. The 1948 and 1949 averages were 19.4 and 16.3 grains per gallon, respectively. The 1950 average to date is 11.1 grains per gallon. The composition of our muck-producing constituents in the gas may have changed, because of the addition of oil to our coal mix to control bulk density. We do not feel this is a fact, but must admit the possibility. A more logical explanation of less muck in the system is that there is a diluting effect due to our pulling all of the oil for bulk density control from the wash oil purifier as sludge oil. Although we do not have complete data on the muck concentration, those we do have show 238 grains per gallon now, against a 368 grains per gallon prior to the adaption of this practice.

We were soon satisfied that the new wash oil was doing as good a job as the old one, at a lower price; more recently, the question has come up whether it is not actually doing a better job. This point concerns emulsification.

According to the supplier referred to above, "It has always been felt that the emulsion resistance of a properly designed wash oil should be controlled." It appears that this characteristic, in the new oil, has been satisfactorily controlled.

From the time our plant went into operation, up to and including the present, we have had trouble reducing the gas temperature to the scrubbers to a reasonable figure in hot weather. This is particularly true if one cooling tower fan is down for repairs. Since our oil system has been staying free of emulsions, it was decided to reduce the temperature of the scrubbing oil to a temperature below that of the gas entering the

Figure 3 — Bottom view of benzol scrubbers showing gas piping. Gasholder is in background.



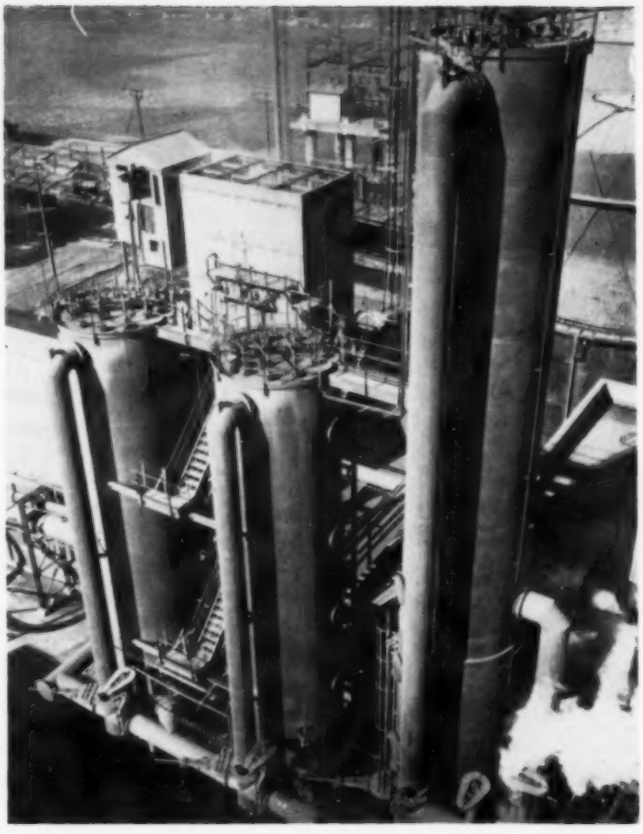


Figure 4 — Top view of benzol scrubbers and final cooler showing wash oil distribution piping holder. Final cooler water cooling tower is in background.

scrubbers. How far this temperature can be reduced we have not yet ascertained, but we are now scrubbing with a four (4 C) differential of oil to the gas and have not encountered any emulsification. This has amounted to light oil recovery, over what we would recover otherwise, of 0.56 gallons per ton. To claim this a direct result of changing wash oil would be unfair, as we never tried this procedure before. Now that we do know this oil allows us to operate in this manner, it is rather definite proof that this type of oil does not easily form emulsions.

It might be expected that, with a lower initial point, we might have found an increase in the amount of intermediate oil produced. "Intermediate Oil" is that oil produced as bottoms from the light oil rectifier; it varies in composition with the way the rectifier is operated. As method of operating this piece of equipment has not changed materially, as a comparison of the range on the intermediate oil before and after changing wash oils shows that no material change took place in its composition, and as our production report does not show an increased volume that is unaccounted for, we conclude that it has not increased our intermediate oil.

Our present oil apparently has not built up any sludge in our benzol scrubbers, because the differential across them is the same as it was with the other oil. It is our practice to pump hot oil over these scrubbers every six months to dissolve any naphthalene which might have passed our final cooler, and to break up any emulsions or dissolve any precipitated gums or muck which may have formed. This procedure is accomplished by cutting the water to the wash oil cooling coils, and pumping the hot oil in the regular manner. Samples of this hot oil have been taken, and are found to vary little in muck content from the regular oil in daily circulation. Since we have had no increased differential across the scrubbers, and the oil, under conditions more advantageous to muck absorption, did not increase in muck concentration, we conclude that our scrubbers are as clean with the cheaper oil as they were with the more expensive one.

This may not be an exhaustive study of the problem, and there may be numerous points that might be discussed more fully, but we feel that the data we have is sufficient to enable us to continue using this oil at our plant at a direct saving on the price of the oil and indirectly on the labor cost on cleaning of our wash oil apparatus. Since our dirty oil is used for bulk density

Average intermediate oil production and composition

January to July	1949	1950
	21,136 gallons per month	21,152 gallons per month
Distillation		
FD	128 C	122 C
5	136 C	130 C
60	184 C	185 C
80	219 C	217 C
90	239 C	232 C
95	268 C	249 C
dry	315 C	295 C
(Fractionated) wash oil	8.6 per cent	7.0 per cent

Figure 5 — Wash oil purifier and wash oil still with light oil rectifier on top right.

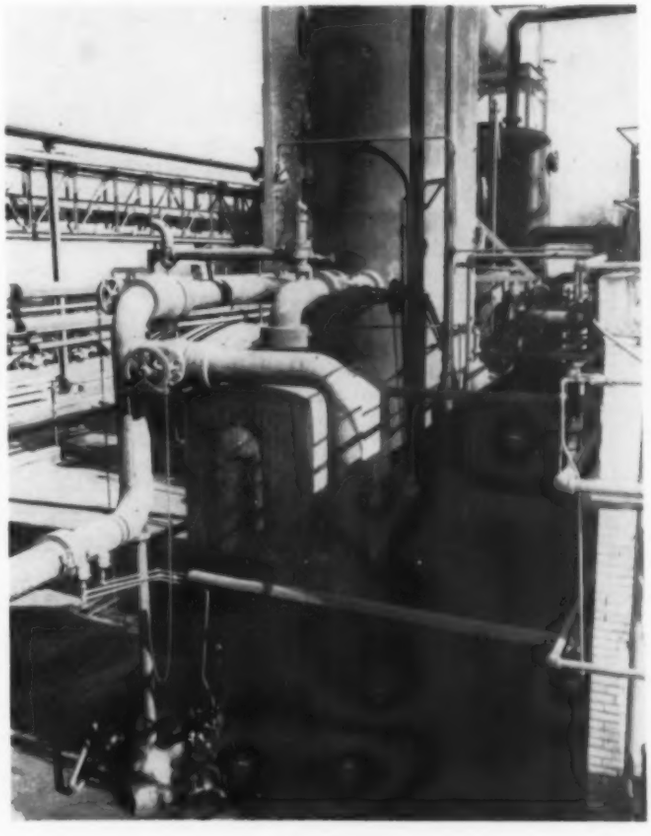


Figure 6 — General view of light oil plant with tar plant on extreme right. Coke battery in background. Note: wash oil still and wash oil purifier feed tank in lower left corner.

control, we also are saving money by using a cheaper oil. We well know that still cheaper grades can be used to control bulk density, but there are several disadvantages in using them which it is not the purpose of this paper to discuss. We are saving a small amount with the lower priced oil in our intermediate, since roughly ten per cent of the intermediate oil is wash oil. The saving is 45¢ per 100 gallons produced or about $3.00 a day, not a lot, but still a savings. Since the oil in use is of a lower viscosity there is a small, but still a real, saving in pumping cost. We realize that an eight month test is of rather a short duration, but it certainly is as long or longer, than most test runs. We no longer consider it as a test, but as a part of our general regular operation.

As we stated earlier in this discussion, our presentation was not meant to discuss all of the theory or refinement in plant design or equipment. Those interested can obtain such information from various sources, such as research groups, industrial designers, planners and equipment manufacturers. We do not claim that all plants will be able to change to a similar oil and obtain the good results we are. Some plants will perhaps encounter conditions which would make changing to a cheaper oil less attractive. Some operators will perhaps be slow as we were in investigating the possibilities of this type of absorbent oil. Old ideas are rigorously cherished. However, for larger plants using and circulating large volumes of wash oil, their saving will be considerable if they are able to use an oil similar to the No. 3 gas oil we are using.

In conclusion, our claims are that with using this type of fuel oil:

1. Our recovery has not suffered.
2. Our system has remained as clean or become cleaner.
3. Our products have retained their same high quality.
4. We are saving 4.5 cents a gallon on this type of oil, delivered at our plant.

DISCUSSION

PRESENTED BY

FRANK McGINLEY, Cities Service Oil Co., Pittsburgh, Pa.

C. VANCE THOMPSON, Superintendent, Coke Plant, Crucible Steel Co. of America, Midland, Pa.

C. R. MONTGOMERY, Chief Chemist, By-Product Coke Department, Pittsburgh Steel Co., Pittsburgh, Pa.

C. HINTZ, Republic Steel Corp., Cleveland, Ohio.

J. K. KURTZ, Superintendent Coke Ovens, Bethlehem Steel Co., Sparrows Point, Md.

J. M. GREEK, Hanna Furnace Division, Great Lakes Steel Corp., Detroit, Mich.

G. W. WALLACE, Technical Director, Freedom Valvoline Oil Co., Freedom, Pa.

PRESTON E. JORDAN, Technical Advisor, Wheeling Steel Corp., Steubenville, Ohio.

GEORGE F. BOWERS, Engineer, Standard Oil Co. of Indiana, Chicago, Ill.

E. C. KENNEDY, Superintendent, By-Product Coke Plant, Carnegie-Illinois Steel Corp., Gary, Ind.

F. McGinley: I am sure that each and every one of you will be most anxious to effect savings such as has been accomplished by Mr. Montgomery in his plant, and I believe the majority of you will be able to do so.

My work chiefly is that of developing and effecting economies for our customers. Some time ago, I was surprised to learn that coke and natural gas industries were using a comparatively high priced special absorbent oil. This to me is not conducive to economical practice, as in petroleum refineries, owing to the huge daily volumes of oil and gas processed, we have been forced to effect economies, and use in some instances, surplus products. Consequently, fuel oil has long been used as an absorbent oil. This has been very economical as well as satisfactory, and of considerable assistance in balancing production, and production must be kept in balance. If not, the cost of some products are unreasonably high and surplus products literally given away; or the alternative of cracking, blending or other costly measures taken to effect a balanced production.

From an oil man's point of view, and speaking for myself entirely, I believe that this development of using a fuel oil as an absorbent oil will change the thinking of refiners which will permit them to bring their production into better balance across the entire year. As we all know, fuel oil is a drug on the market in the summer months, requiring a great investment for storage facilities, rehandling, or cracking. I believe, however, following the patterns adopted by Mr. Montgomery, creating a year round demand will afford refiners greater profits and interest them in the promotion of the sales of this type absorbent oil.

Old established practices are hard to change, especially when no trouble is encountered. In large companies and corporations, with the number of persons involved, this is especially true. The proposal to effect this change, after we introduced the idea to Mr. McAndrews, their purchasing agent, required a time lapse of six months to enable them to put this change into practice. I wish to point out that it necessitated the utmost cooperation and approval between the purchasing department, the plant superintendent, C. Troop, and C. R. Montgomery. This matter did not receive the endorsement of some of the coke plant manufacturers or the oil companies, and required a great amount of courage to invoke. It required not only courage but confidence of the individuals involved and utmost cooperation between all parties to embark on a practice so foreign to existing practices. This courage has been vindicated.

There is nothing further that I can add to Mr. Montgomery's very complete paper, except that there is an old adage "the proof of the pudding is in the eating." I sincerely believe that Mr. Montgomery has shown the way to save thousands and thousands of dollars per year by utilizing this practice, depending, of course, on the size of the operation.

C. Vance Thompson: Thus far your use of No. 3 gas oil has proved very satisfactory as compared with absorbent oil performance. Your experience with absorbent oil closely parallels our experience in the use of the same. However, for general information, before we installed our continuous wash oil purifier, we encountered troublesome settled sludge throughout our wash oil system. We corrected this by adding 0.3 per cent of a hard wood tar distillate to our wash oil system. This kept the sludge in solution, possibly inhibited its formation, but, of course, did not clean the wash oil.

We have had one unique experience with absorbent oil in our gas washers. During a period of reduced operations, a high differential pressure developed in our scrubbers. We naturally suspected that this was due to sludge deposition on the spiral turnings. We circulated hot wash oil and crude solvent through the scrubbers but with no favorable results. We then resorted to steaming and were surprised when we reclaimed only oil and water but no sludge and the high differential pressure condition was immediately corrected. However, this condition can be explained by the fact that the wash oil temperature was less than the gas temperature which caused a deposition of H_2O into the wash oil, hence forming an emulsion.

The 37 F pour point of No. 3 gas oil raises doubt in my mind as to its performance during severe winter conditions. We use as part of our specifications for absorbent oil that there be no thickening at 39.2 F. An oil with a pour point of 37.0 F would be quite viscous at 39.2 F and we have encountered temperatures in this vicinity in severe winters.

I would like to ask at what price the author obtains the No. 3 gas oil delivered at the plant?

C. R. Montgomery: $0.0925 a gallon.

C. Hintz: Mr. Montgomery and his associates have hit upon something of real value. A savings of 4 cents per gallon plus the reduction in equipment cleaning and a resulting steam reduction is something we can all use.

We have used wide range absorbent oil from time to time, but never long enough to obtain any data. This was only done because of a shortage of wash oil, and for only short periods, but we never noticed any trouble due to the change.

We are contemplating changing to No. 3 fuel oil after having read this paper but I believe a slow dilution of the present oil should be made and sufficient data obtained to be sure that the changeover will be profitable.

Those of us that do not have a light oil rectifier may find more residue due to the lower boiling point of the fuel oil.

I also believe that constant removal of oil from the system as described in Mr. Montgomery's paper resulting in a clean oil of only 11 grains per gallon of muck is probably the reason for no increase in the scrubber differential rather than the type of absorbent oil used.

J. K. Kurtz: Mr. Montgomery has done the coke oven industry a service. For years we have been in a rut on wash oil, each plant pretty much deciding for itself what oil it wanted. By using an entirely different type of oil with satisfactory results, Mr. Montgomery calls attention to the fact that we still have much to learn. He also says quite frankly that while this oil has proven satisfactory it is not necessarily the optimum absorbing oil.

Work done by the Bethlehem Steel Co. Research Department indicates quite definitely that the lower boiling oils have lower molecular weight and greater absorption capacity. In our Sparrows Point plant, experimental work has shown that of the oils tested the most satisfactory was one with a boiling range from 270 C to 320 C.

With a potential market of more than 20,000,000 gallons per year it would seem that the larger oil companies would be interested in making further studies in conjunction with the operators. Let us hope that what Mr. Montgomery has started is not the end but just the beginning of a real study of absorbing oils from all phases.

J. M. Greek: The wash oil we use at Great Lakes Steel Corp. conforms fairly closely to the specifications quoted from "Coal, Coke and Coal Chemicals." We determine viscosity at 70 F rather than 100 F. Recent results on new oil range from 74 to 85 S.S.U. at 70 F. The 74 viscosity oil had a reading of 59 when tested at 100 F. Our steam distillation test calls for treating 500 ml oil until 500 ml condensed steam has been collected. This test shows 1 ml oil distilled over, on the average. Emulsification tests show 100 per cent separation in from less than one minute to as much as six minutes. In general, about three minutes are required for 100 per cent separation. We also specify that the main body of oil in the steam distillation test should completely separate from the water, showing a sharply defined line of division fifteen minutes after steam is turned off. Olefins in our new wash oil have been averaging about 16 per cent recently. Our method is somewhat more drastic than the test mentioned which gives us a somewhat higher result.

Operations at our plant differ in several respects from the one at Monessen. The fact that we have no saturators and no conventional final cooler makes direct comparisons difficult. We add tar to the cooling liquor

going to the secondary stage of our primary cooler system. The gas reaches its lowest temperature at this point and tar is present to absorb and carry naphthalene away. We believe unsaturates that might otherwise contribute to muck formation are scrubbed out of the gas at this point by the tar. Our temperatures during warm weather are as low as we can get by using Detroit River water in our shell and tube coolers, both on wash oil and liquor to coolers. For this reason we have no way to try oil at a lower temperature than the gas when light oil recovery is off a bit. It is doubtful that we would care to risk it, even if possible, with the oil we are using and under our set up. However, it certainly appears advantageous at Monessen; added recovery of over ½ gallon light oil per ton is well worth while.

As Mr. Montgomery indicated, not all plants could be expected to follow their experience exactly. For instance, our light oil has a dry point of 155 C compared to their 115 C. This leads to much higher boiling intermediate oil in our case, only 5 to 10 per cent of which distills under 200 C. We would be concerned that an absorbent oil with some light ends, such as their No. 3 gas oil, would unduly contaminate our product. It can now be marketed for its high naphthalene content.

We very seldom find it necessary to clean our final oil heater. Benzolized oil enters it from the oil-to-oil heat exchanger at about 98 C and leaves at 125 C. Our current figure for muck in the oil is 28.7 grains per gallon. We clean our wood grid packed light oil scrubbers annually using a residual high boiling solvent accumulated from our final pure still column reboiler. We have had no occasion to dispose of any dirty oil and have found this annual cleaning adequate.

It would be interesting to know how much dilution of their wash oil system with new oil takes place due to the withdrawal of dirty oil for coal density control. Could Mr. Montgomery give us some data on this point? Our consumption of wash oil averages 0.03 gallon per gallon of light oil.

C. R. Montgomery: We used to draw off two hundred gallons a day of the high priced oil. Now we are drawing four hundred gallons a day, because that is the approximate gallonage that we need for our bulk density control on the ovens, so you can see that it is an increase of two hundred gallons a day. The increased use is due entirely to our coal handling departments needs. With a light oil make of 6500 gal per day, this is nearly twice the figure you quote of 0.03 gal of oil used per gal of light oil produced. To charge this increase of oil used to the light oil department would be wrong, and we would go back to our original figure of 200 gal per day, which makes the oil use about the same as yours for accounting purposes, but twice yours for change over per day.

G. W. Wallace: My comments will be from the standpoint of a refiner and supplier of absorbent oil. I would like to point out that the product currently being supplied to most plants is manufactured to meet specifications set up by these same plants. Fortunately or otherwise, no two operators agreed exactly on these specifications so that now products are furnished to meet the most exacting of all the tolerances on each test. For example, where one plant will tolerate a distillation range of 500 to 700 F and another 550 to 675 F, we of course supply the 550/675 range to both consumers. Our experience indicates that the closer fractionated oil will minimize difficulties in all plants. It would be impossible for refiners to supply each plant with a product meeting his own specifications. This would make each customer's requirements a special product even more expensive than the present absorbent oil. Since the consumers laid down certain specifications that must be consistently met by using additional refining operations, we believe the industry is justified in a small premium in price over the value of charging stock used to produce these absorbent oils.

The physical tests of the No. 3 gas oil used by Mr. Montgomery show properties which we have been informed will cause considerable trouble in operation. First, the low IBP should cause dilution of the intermediate oil. Mr. Montgomery has stated no unaccounted for increase in volume, but I would like to ask if he has noted any change in Kauri butanol solvency of this cut? With an IBP as low as indicated, a very efficient column would be required for separation of the higher boiling aromatics and the wash oil. Failing in this, dilution and consequent degradation of these higher aromatics would result. The EP is much higher than most companies like; however, in this case it may not be detrimental since it is the result of a small "tail" on the distillation, the 95 per cent points being practically identical. We find it hard to reconcile the olefin figures on two such products shown in the comparison table. We would expect to find a much higher olefin content in the No. 3 gas oil since it is obviously a longer cut receiving less refining than regular absorbent oil. There is some divergence of opinion as to how the olefin test should be run, and we know from experience that different laboratories using the same method will not always check. I would like to ask Mr. Montgomery if his method involves just 95 per cent sulphuric acid or the mixture of 95 per cent and fuming? I do not believe we could sell most of the operators we know on the idea of using a 40 pour wash oil. Realizing of course, that all operations are different, and Mr. Montgomery apparently has no trouble with this high pour material, from a suppliers standpoint we still must furnish a product with a pour point to meet the lowest operation condition of our most critical consumer.

We would also like to point out that the term gas oil is a rather loose term applied to a wide variety of refinery cuts used primarily as cracking stock. Therefore, gas oil as received from one plant is not necessarily the same as that from another. Mr. Montgomery apparently has received his supply from one refinery and thus far has not found it necessary to augment his needs elsewhere. When and if this is necessary, or if others can use this type of material, it will be necessary to specify the type of distillate and the usual physical properties. This of course brings us right back where we are albeit with slightly wider tolerances, but still requiring special treatment by individual refineries. By lowering our standards, naturally the product can be produced at a lower cost. However, prices the past year would not indicate the 4½¢ per gallon saving indicated by Mr. Montgomery. A check on posted prices would show a savings as of today of 1⅞¢ per gallon.

One other item bears noting and that is the increased recovery of light oil. According to graphs and data published by Glowacki in his work, previously recommended by Mr. Montgomery, light oil recovery is directly related to the absorption temperatures, whereas the absorptive capacity of the wash oil is much less critical than the effect of temperature change. This would indicate little or no relationship between the improved operation and the oil, assuming of course that a properly refined oil of good demulsibility is used.

Mr. Montgomery also points out that his system is cleaner and his wash oil muck has been reduced. Comparative figures on his quantity of make-up using the No. 3 gas oil as against his original absorbent oil would be interesting.

C. R. Montgomery: We do not run the Kauri butanol solvency test, so I cannot give you an answer on that. We do not have a very efficient column at the plant for rectification of the light oil wash oil mixture. Our tests do not show that separating material of a 218 C BP (naphthalene) from the wash oil IBP—230 C and 5 per cent—278 C, to be nearly as difficult as Mr. Wallace indicates in his remarks.

The olefin figures were obtained by using 100 per cent sulphuric acid in the test. Both oils were tested at the same time under completely similar conditions. Mr. Wallace's company was asked to submit to us a complete analysis of their No. 3 gas oil prior to our reporting our laboratory results in the paper just read. We received a pour point and a specific gravity figure and that was all.

The 4½¢ per gallon figure was given to me by our purchasing department. How this is arrived at I believe is to take the price we were paying for oil delivered and subtracting the price now paid. The difference must be the figure given me. I will admit, that to obtain the oil we wanted, we did change suppliers, and as formerly we did not buy from Mr. Wallace's company, their prices compared to what we were paying must be a couple of cents a gallon different.

I believe I have given figures on the amount of make-up oil now in use in one of my other remarks.

In answer to the yields, we are, and were experiencing with the two oils, is that they are regular production figures reported by the accounting department. Apparently we are getting a slightly better recovery with this lower boiling oil than before, and I think that a definite relationship does exist in favor of the lower IBP and lower priced oil. Mr. Kurtz and his co-workers at Bethlehem Steel have just reported better absorption with lower boiling oils than most plants have used in the past.

You mentioned that it would be difficult to sell most of your customers on a 40 F pour point oil. We gave this considerable thought but nowhere in our system does our temperature drop this low even in very cold weather. We did freeze our wash oil storage tank solid using our previous oil, when the temperature dropped to —20 F. At that time we did not have heating coils in our wash oil storage. No doubt a little more attention to the wash oil system will have to be given to insure the lines are blown-out well in case of an emergency shutdown in severe weather. Our operators have been instructed on this point.

Preston E. Jordan: I would like to know how much oil is in the system, how much coal is carbonized per day, and how much gas the author has per day?

C. R. Montgomery: About twenty thousand gallons of oil are in the system. We carbonize two thousand tons of coal per day. We have a little better than twenty and one-half million cu ft of gas.

Preston E. Jordan: How much volatile matter is in the mix?

C. R. Montgomery: The mix is about 30.4 monthly average.

George Bowers: I would like to make one comment and that is that the particular product that we are talking about is the so-called center cut that has become so much in demand recently. At one time it was a drug on the market in the summer time, but with the increased use by the diesel engine, we are under continual demands for the product. The future is going to see increased amounts of "cracked" material used to procure additional fuel from this particular cut. The result is going to be a very greatly increased percentage of unsaturates. These unsaturates could result in additional sludge problems, so any consideration on the use of fuel oil for this service should be made on the basis of, should I say, coming material which would be more unsaturated than the No. 3 gas oil that has been discussed.

E. C. Kennedy: We circulate about one hundred fifty thousand gallons of oil per hour, and of course, we handle quite a good deal of oil in the system. The former specifications that Mr. Montgomery was using, were 32 C higher on the boiling point than we have used for so many years that we have forgotten the specifications. He is now using an oil 20 C lower than we are using and we would not anticipate any trouble with this oil.

However, I was badly misled. Sometime ago, I received a notice from, I believe, purchasing and they stated that several large steel companies were now using No. 2 fuel oil in their system. It happens to have a boiling point down around 169 C, and I have investigated, so far, and have not found anybody that will admit using it. If you are not using it, I wish our purchasing department would not consider it, because I have been informed that the oil companies are in no position to furnish it anyway.

Since Mr. Montgomery is using a twenty degree lower boiling point, I believe we could get by with it. He is using a better oil than before in regards to viscosity. There is one question in my mind. Would he feel like going down to 169 C on the boiling point?

C. R. Montgomery: I do not feel that I could go that low, but I think we could go considerably lower than we are using in the No. 3. I hesitate to say that we can definitely, because I would have to do some work on that to see if it is possible. I think we can go lower but not to a temperature below the boiling point of naphthalene with our present set up.

E. C. Kennedy: You are selling your intermediate oil as such?

C. R. Montgomery: We are selling the intermediate oil as such. We have not receved any complaint from the distiller.

INDUCTION HEATING IN THE STEEL INDUSTRY

. . . . induction heating has the advantage that it generates the heat at the spot where it is desired . . . .

By E. H. BROWNING
Metal Working Section
Westinghouse Electric Corp.
East Pittsburgh, Pa.

▲ INDUCTION heating is not a new tool in the metal working industry nor is its use in any way foreign to the steel mill industry. However, on a "number-of-equipments" basis, the most extensive use of induction heating is found in the automotive, machine tool and parts, and mobile equipment industries and in plants which manufacture, assemble, and heat treat small parts. Of course, the use of the induction furnace in foundries, metallurgical laboratories, and steel mills is quite extensive; but the use of induction heating processes as compared with other methods of heating, such as gas and oil burning processes, is at present relatively small in the overall steel industry.

Impetus was given the use of induction heating processes in the steel mill industry during the war years. In the years that followed 1941, we have seen approximately 9000 kw of radio frequency equipment placed in steel mills for use in flowing tin on electrolytically coated tinplate. One large producer of electrolytic tinplate presently is installing 600 kw of radio frequency generating equipment to be used in conjunction with other existing radio frequency generators on an electrolytic tinning line which will operate at about 2000 fpm. Another is adding 200 kw to an existing 400 kw, 200 kc equipment. Also, one steel company has installed rotating high frequency generating equipment for the purpose of continuously galvanizing heavy gage steel strip at a maximum speed of 120 fpm. This company is also installing a similar line for lighter gage strip. Other uses to which induction heating has been put in steel mills include induction furnace melting for laboratory analysis, tool repair work such as carbide tipping of cutting tools, weld annealing and heating for purposes of upsetting and forging.

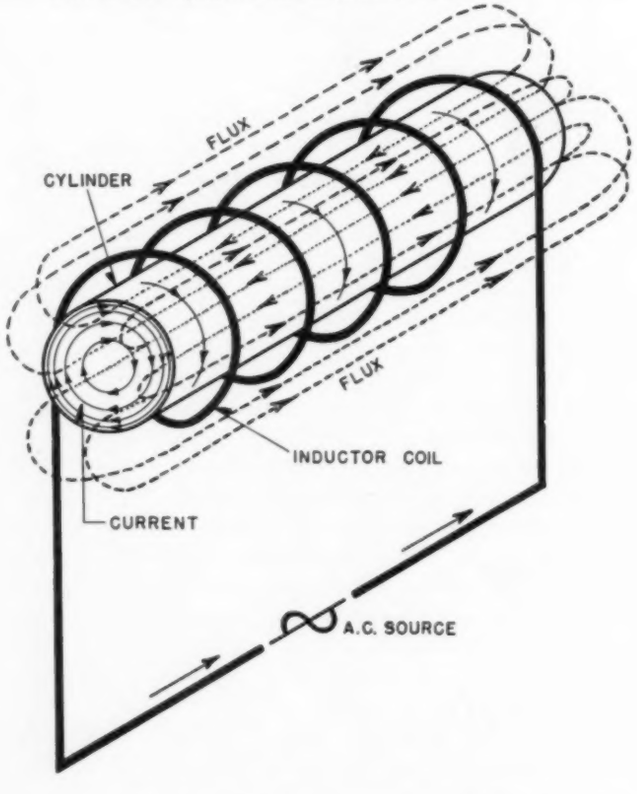
There are other promising opportunities for the application of this form of heating and these shall be covered later.

At this point, a brief review of what induction heating is may be in order. Induction heating, or heat resulting in conductors from magnetic induction effects, is essentially I^2R heating or the power dissipated by the flow of current through a resistance. This heating is present in most electrical circuits and machinery to some extent, and great pains are taken by designers to minimize them as much as possible since in ordinary circuits and machinery it represents loss or non-utilization of power as intended.

Just as certain things such as lamination of metal in transformer cores, dynamo rotors and stators, are effected to reduce heat losses due to induction, so may other things be done to increase the heating of metal parts located in varying magnetic fields. Such is the case, of course, in induction heating processes and applications wherein the aim is to generate heat as efficiently as possible as well as to more or less localize it.

Figure 1 illustrates a metallic conductor — magnetic or non-magnetic — inserted in a helical coil. The terminals of this coil or inductor are connected to the terminals of an alternating current generator of suitable frequency. An alternating current flows through the helical inductor and an alternating flux is set up which passes longitudinally through the conductor inserted in the coil. Thus, we have a conductor located in a magnetic field such that a closed path for current flow is offered. Examination of the illustration indicates that we have here in form a simple transformer in which the

Figure 1 — Sketch illustrates the flux and current paths for a metal cylinder in an inductor coil.



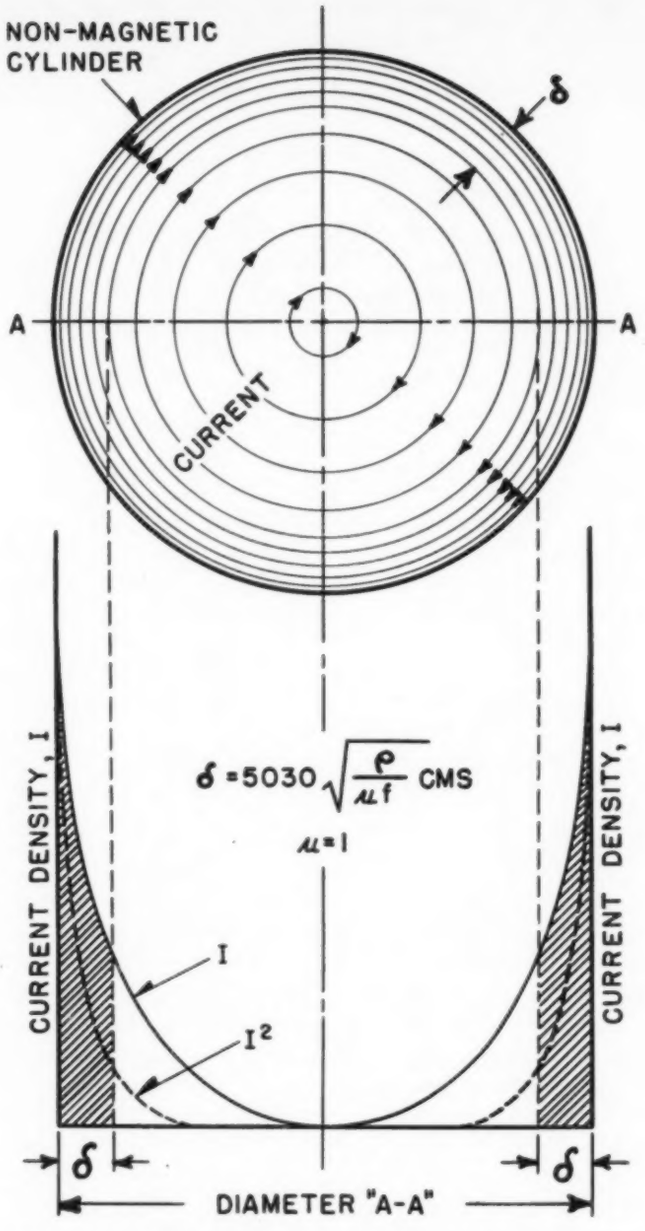


Figure 2 — Sketch of the effective depth of current penetration, δ into a non-magnetic cylinder.

helical coil constitutes the multi-turn primary winding and the inserted conductor a single turn secondary winding. The flux path consists of air and the conductor material. Therefore, since an alternating current voltage is impressed on the primary winding or helical coil, we can expect that an alternating current voltage of the same frequency will be induced in the single turn secondary winding. This causes a current to flow in the secondary conductor, and since this conductor has resistance, an I^2R loss results and heating of the conductor takes place.

It will be noticed that the current in the inserted conductor flows in a direction opposite to the current in the inductor coil and that the density of the current is represented as being greatest near the surface of the conductor and decreases as the center of the conductor is approached.

Figure 2 represents a cross-section of the conductor and illustrates this decrease in current density from the surface of the conductor towards the center. Therefore, most of the current flows near the periphery of the conductor and thus the heat generated near the surface is greatest. This brings us to the "depth of penetration" concept. This is not a physical quantity but is a mathematical quantity useful in the calculation of induction heating conditions. It can be defined as the calculated depth from the conductor surface in towards the center of the conductor in which, if the total induced current were flowing at a uniform density, the total heating obtained would be equal to that obtained with the non-uniform current density condition as actually exists. The expression for the depth of penetration is

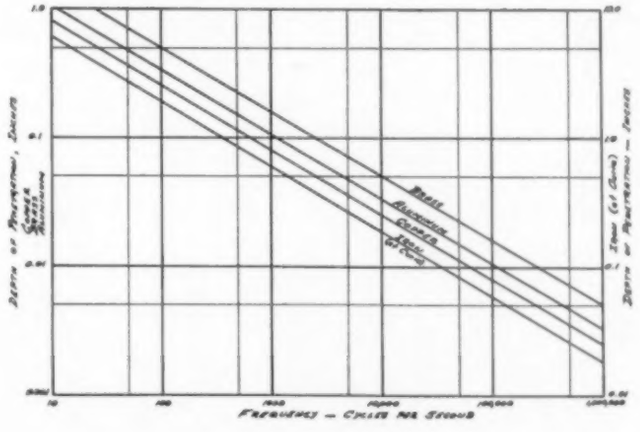
$$\delta = K_o \sqrt{\frac{\rho}{\mu f}}$$

where δ = Depth of penetration.
K_o = A constant.
ρ = Specific resistivity of the inserted conductor metal.
μ = Permeability (unity unless metal is magnetic).
f = Frequency of power supply to the inductor coil.

The above expression allows us to draw some conclusions relative to the effects of the conductor or work piece resistivity and permeability as well as to the frequency employed. It is seen that a metal with a low resistivity would have a small depth of penetration at a given frequency, whereas another metal of the same characteristics, but of higher resistivity would have a larger depth of penetration at the same frequency. It is noted that as the frequency used is increased, the depth of penetration decreases. Also metals having high permeability (magnetic) will have a lesser depth of penetration at a given frequency when compared with metals of lower permeability (non-magnetic), if resistivity of the metals are comparable. It is important then to consider whether the metal to be heated is non-magnetic or magnetic. Figure 3 shows plots of depth of penetration against frequency for some of the more common metals met with in induction heating work.

With the above in mind, we can in a general sense say that for large pieces of metal which are to be through heated, a lower frequency can be used than for through heating of small pieces of metal.

Figure 3 — Depth of current penetration decreases with the frequency.



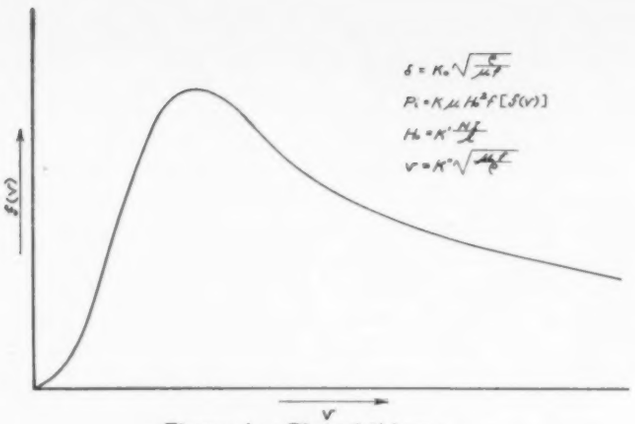
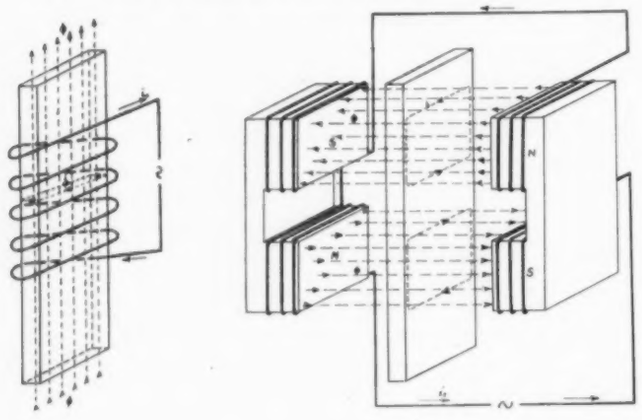


Figure 4 — Plot of $f(\nu)$ vs ν.

Figure 5 — The sketch on the left shows one form of heat known as longitudinal flux heating. The sketch on the right shows transverse flux heating.



Reference to the expression for the depth of penetration indicates that the heating of a metal piece can be localized at or near the surface (higher frequency) or generated over a large cross-sectional area of the piece (lower frequencies). Therefore, in the case of surface hardening, brazing, and soldering, a high frequency generating equipment is usually employed whereas for heating for forging, annealing and the like, relatively low frequency is used. This, then, is one of the prime advantages of induction heating; that is, the heat generation can be controlled and the heat is generated in the piece to be heated; and in most cases, at the location desired.

Regarding now that a certain amount of power is needed to heat a piece of metal to some temperature in a given time, we must then determine the design of an inductor coil which will be practical and which will have the ability to magnetically couple the required power into the work to be heated. One form of an expression representing power input to a piece of metal being inductively heated is

$$P_i = K\mu H_o^2 f[f(\nu)]$$

where: P_i = Power input.
K = A constant.
μ = Permeability of the metal (unity unless metal is magnetic).
f = Frequency.
$f(\nu)$ = A function which takes into account the time phase relationship of the currents flowing inside the work piece due to the induced voltage.
H_o = Peak magnetizing force at the surface of the work piece.

$$H_o = K'\frac{NI}{l}$$

where: K' = A constant.
N = Number of turns in the inductor coil.
I = Inductor coil current.
l = Inductor coil length.

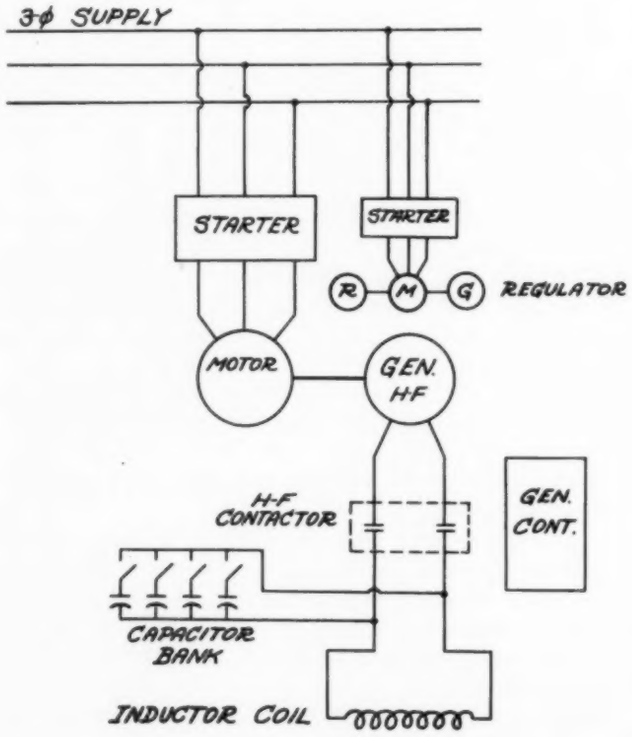
Since $f(\nu)$ affects the amount of power which can be coupled into the work piece, the form of the expression for ν is given as follows:

$$\nu = K''\sqrt{\frac{\mu f}{\rho}}$$

where:
K'' is another constant for a definite work piece and μ, f, and ρ are as defined before. It is interesting to note that the equation for ν is similar in form to the reciprocal of the equation for the depth of penetration. Figure 4 shows a plot of $f(\nu)$ against ν and it will be noted that for a certain definite value of ν, $f(\nu)$ is a maximum. Reference to the expression for power input indicates conditions should be such that $f(\nu)$ is a maximum since then the coupling of power into the work piece is accomplished under the most practical circumstances.

Study of the above equations causes us to conclude that a definite interdependency exists between several entities, and that care must be taken in choosing such factors as frequency and coil turns. The foregoing is one basis for induction heating calculations and, as given, applies mainly to the through heating of metals. The

Figure 6 — Schematic diagram for a typical induction heat installation.



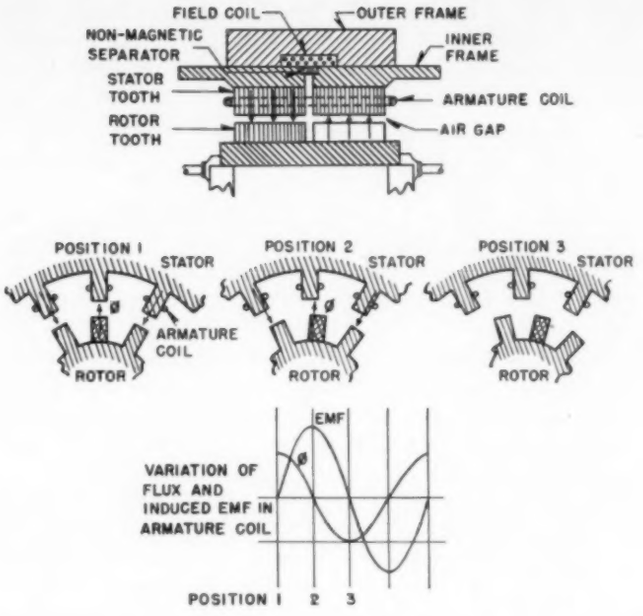


Figure 7 — Cross-section through high frequency inductor type generator.

results obtained are in most cases tempered by empirical factors and also by the standardization of commercial high frequency generating equipment available. In applications involving heating of tubular conductors, heating for purposes of brazing, annealing, hardening, etc., other factors not herein discussed enter into the design of the most practical induction heating system, but the approach to the problem is essentially along the same lines.

At this point, let us consider two forms of induction heating equipment which offer means for the heating of metal sheet, strip, and slabs. The first is the form which we have just been considering. Here the inductor coil surrounds the metal to be heated and the flux set up is parallel to the longitudinal axis of the sheet, strip, or slab. In this form, or longitudinal flux heating, the induced current flows essentially around the periphery and perpendicularly to the longitudinal axis of the metal being inductively heated. The left side of Figure 5 shows this. The other form, known as transverse flux heating, is such that the flux is perpendicular to the longitudinal axis of the sheet, strip, or slab; and the current flows not around the outside of the metal cross-section but across the metal and also parallel to the longitudinal axis of the metal at the edges. The right side of Figure 5 shows this.

Generally, longitudinal flux heating is best for magnetic sheet, strip, or slab; and for non-magnetic sheet, strip, or slabs of reasonable thickness. For relatively thin non-magnetic sheet, strip, or slabs — and included in this category is iron or steel at a temperature above the Curie point (low permeability state), transverse flux heating offers considerable advantage.

Figure 6 shows a schematic diagram for a typical induction heating installation. In the case illustrated, a high frequency generator supplies the power to the inductor coil which in turn couples by magnetic induction power into the work piece located in the inductor. The inductor coil is usually made of water cooled copper tubing of one or more turns. In certain cases, copper strap is used with copper tubing brazed or soldered to it for water cooling purposes. In other instances, mainly dictated by the need for definite location of heat generation, the inductor may assume the proportions of a split and drilled block of copper with facilities for water cooling. In this latter case, a transformer may be interposed between the generator and the inductor block to give the high coil currents required.

Capacitors are usually connected at or near the terminals of the inductor coil when the high frequency power supplied to the coil is generated by rotating equipment. The reason for this is that the power factor at the terminals of the inductor coil with the work piece inserted in the coil is relatively low. Therefore, the capacitors are required to supply the lagging volt-amperes to the coil. By designing the coil such that the space between the turns and the work piece is kept to a practical minimum, the power factor can be kept within reasonable values and the amount of corrective high frequency shunt capacitance required maintained at a minimum value. Inductor type generators are designed for unity power factor loading, thus, the parallel combination of the capacitors and the inductor coil plus work piece must present a power factor at or near unity for this form of generator. For electronic generators (oscillators), this is not the case since this form of equipment can inherently operate into a low power factor load. The capacitors are present, however, in the tank circuit of the generator.

There are several types of electrical generating equipments which can and are being used for providing power for induction heating processes. These are synchronous machinery, induction frequency changers, inductor type generators, spark gap oscillators and vacuum tube oscillators.

Rotating equipment is practically limited to generation of power at frequencies ranging from 25 to 10,000

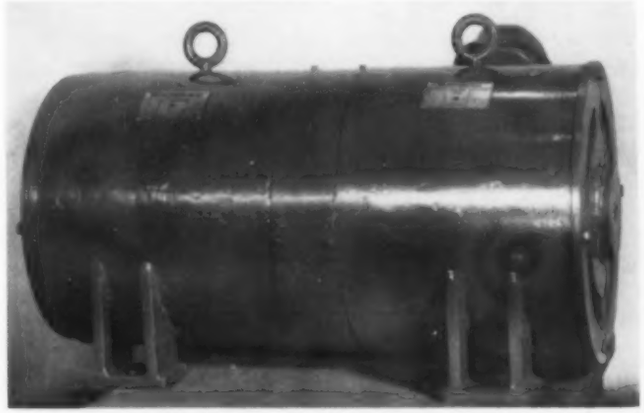


Figure 8 — The generator shown is rated at 20 kw, 10,000 cycles per sec at 3600 rpm.

Figure 9 — The high frequency motor generator set illustrated is rated at 500 kw, 9600 cycles, but some have been built up to 1500 kw at 3000 cycles and 900 kw at 9600 cycles.

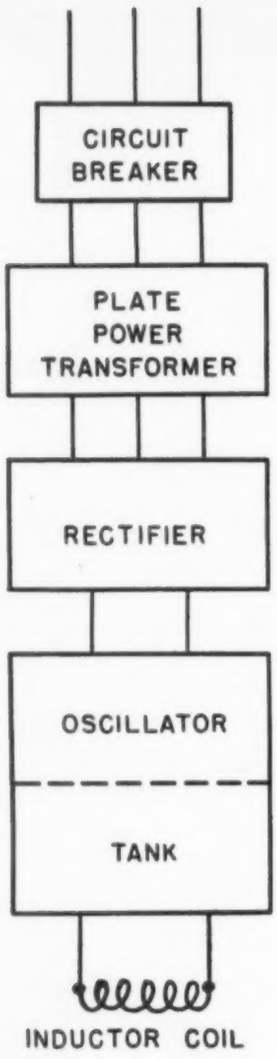


Figure 10 — Block diagram of an industrial radio frequency generator.

cycles although inductor type generators have been designed to provide 30,000 cycle power. Spark gap oscillators have been used for low power induction heating work at frequencies of the order of 15 kilocycles to about 150 kilocycles. Vacuum tube oscillators with a frequency range of from 185 to 450 kilocycles are presently enjoying extensive use in the metal working industry.

By far, on a unit basis, the most used equipment for induction heating power generation is the inductor type generator which has been commercially perfected to make available frequencies from approximately 1000 cycles per second to 10,000 cycles per second. Frequencies more commonly met with are 960, 3000, and 9600 cycles. Power ratings for inductor generators normally range from 7½ kw to 1500 kw.

Figure 7 shows a representative axial cross-section of one form of inductor type generator. The field coil shown sets up the uni-directional flux in the iron of the stator and the rotor. The coil in which the high frequency voltage is induced is wound in slots on the stator; there is no coil on the rotor and, therefore, no electrical connections to the rotor. The teeth on one-half of the rotor are displaced 180 electrical degrees from the teeth on the other half of the rotor, and there are normally twice as many teeth on the stator as on the rotor. As the rotor revolves, the reluctance of the flux path consisting of the rotor, stator, and air gap is varied and an alternating voltage is induced in the stator winding. By proper proportioning of the number of teeth on the rotor and stator, and the speed of rotation of the rotor, the desired design frequency can be obtained. Speeds of rotation for this type of generator are usually 1800 rpm or 3600 rpm.

Figure 8 shows a 20-kw, 10,000 cycles per second, 3600 rpm, two bearing, air cooled, high frequency generator. For higher ratings up to about 150 kw at 10,000 cycles, this form of generator is totally enclosed and water cooled.

Figure 9 illustrates a 500-kw, 9600 cycle, totally enclosed, four bearing, hydrogen cooled, high frequency motor-generator set. Many of these sets are in service and performing commendably. This type of set has been built up to 1500 kw at 3000 cycles and 900 kw at 9600 cycles. The use of hydrogen as a coolant permits set efficiencies of the order of 80 per cent to be realized at a generation frequency of 9600 cycles per second.

Electronic or vacuum tube generators rated from 2 kw to 200 kw are being used for operations such as brazing, weld annealing, surface hardening, gear hardening, and other heating processes wherein localization and close control of heat generation is a prime requirement. Also, radio frequency equipment is being used to supply power for the flow brighteners on electrolytic tinning lines. These electronic generators are similar to radio broadcasting equipment but are somewhat simpler. Figure 10 shows a block diagram of an industrial radio frequency generator. Here, power from a three phase supply is furnished a rectifier plate transformer through a suitable circuit breaker. A mercury vapor rectifier converts the a-c power to d-c power and supplies the vacuum tube oscillator and its associated tank circuit. The frequency of oscillation is determined by the capacitors and inductance (including that of the inductor coil) of the tank circuit.

Figure 11 — Some induction furnaces are particularly useful in laboratory work.

For a continuous process involving the heating of strip, the initial cost for induction heating may run about $200 per kilowatt for 10,000 cycle rotating equipment and about $300 per kilowatt for 200 kilocycle or radio frequency equipment.

At first glance, this initial cost of induction heating equipment appears to be prohibitively high when compared to some other methods of heating. In a large number of cases, a closer study of the proposed application confirms the correctness of this impression. In other cases, however, a full appraisal of the equipment, installation, and results obtainable through the use of induction heating clearly point out that its advantages are of such nature as to relegate first cost to the status of an acceptable factor if not indeed a factor of secondary importance.

Heating by magnetic induction best lends itself to a process involving continuous production. Compared to other means of heating, it usually consumes less floor space which, in many instances where floor space is at a premium, can be considered as a point of paramount importance. The ease and rapidity with which a heating job can be accomplished makes its use attractive. Since the formation of scale on ferrous metals is a function of time at temperature, induction heating can contribute directly to the reduction of scale formation without the need of controlled atmospheres. Because of the flexibility and the close control afforded by electrical equipment, process outputs can be easily and readily varied to match succeeding operations.

Localization of heating has been mentioned before as being one of the main advantages of induction heating. The heat can be generated in the work piece at the point it is needed and, therefore, in certain cases, an actual decrease in energy requirements can be realized in a comparison with other possible ways of accomplishing the operation.

One other advantage which can be stressed on some occasions is that the heating can be obtained without being accompanied by products of combustion or other undesirable uncleanliness which detracts from the working conditions.

The following material will briefly cover those particular processes which are being used by the steel industry at present and those which may come into use in time.

Figure 11 shows a small induction melting furnace in the pouring position. Small furnaces such as these are useful in steel mill laboratories, and several mills employ them for analysis work. The ease and rapidity of melting, the close temperature control obtainable and the electro-magnetic stirring action which takes place in the induction melting furnace makes it extremely valuable for alloy steel experimentation. For foundry work, the induction melting furnace offers many advantages among which is its ability to provide a means for fast melting of the metal in reasonably small quantities.

Tin reflowing has been touched on previously, but there is much more which can be discussed on this particular subject. Figure 12 shows part of the inductor or brightener coil which couples power into the steel strip for the purpose of melting the tin coating which has previously been electrolytically deposited on the tinplate. The melting of the tin changes the appearance of the strip surface from a matte to a bright, shiny appearance and results in a surface having minimum porosity and better bonding of the tin with the steel. This particular coil, only part of which is shown in this illustration, is about six feet in active length and 12 feet in actual length. It was designed for a power input to the strip of approximately 1200 kw at 185 kc and a strip speed of 1000 fpm to 1200 fpm maximum depending on the width and gage of the strip being processed. This particular line's capacity was increased by the addition of another 200 kw, 185 kc oscillator equipment with the result that strip speeds of around 1350-1400

Figure 12 — Induction heating has been used extensively in tin reflowing operations.

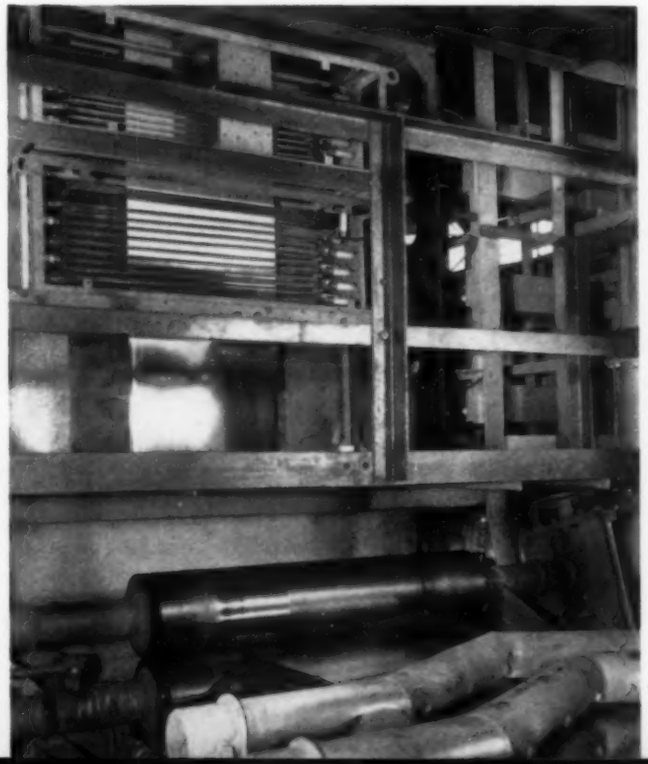
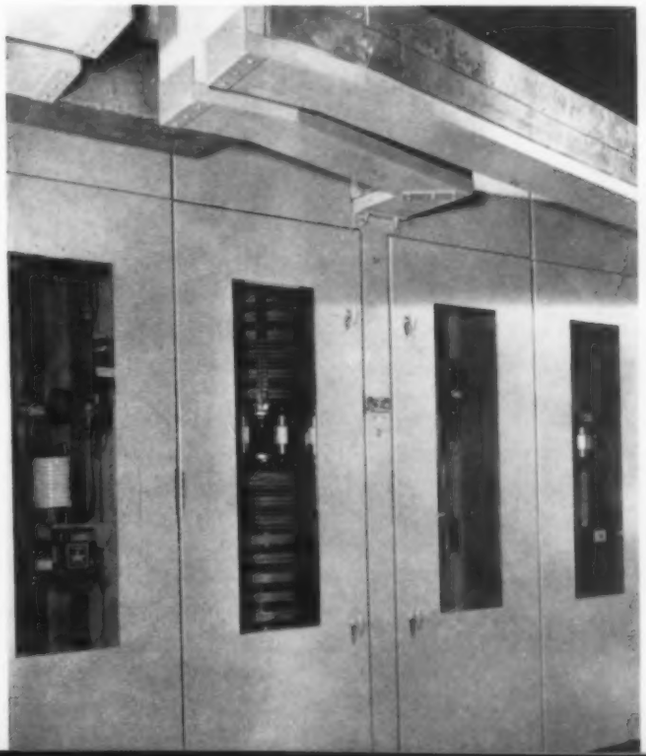


Figure 13 — The 185-kc generator equipment shown is used to generate the power for the operation illustrated in Figure 12.



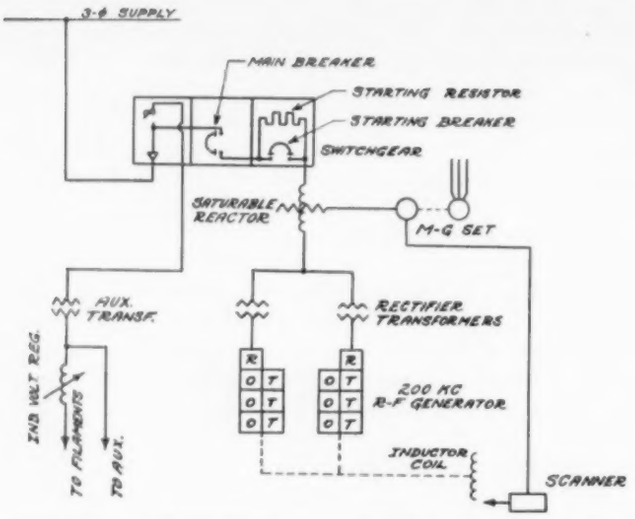


Figure 14 — Schematic diagram for tin reflow operation.

fpm are obtainable. The strip sizes considered here are of the order of 0.0088-0.01 in. thickness and 28-30 in. width.

Figure 13 shows a view of the 185 kc generating equipment and the transmission lines. This illustration shows the general form of radio frequency equipment supplied for tin reflow applications. The complete generator is made up of unit oscillators and associated tanks rated at 200 kw output each. Thus, for a 1200-kw equipment, six of these units having two oscillator tubes each would be combined. One rectifier equipment is used to supply each group of oscillators rated at 600 kw.

Oscillator tube life has increased greatly over a period of years and some plants are averaging 7500 hours per tube. Some tubes have had lives of over 10,000 hours. Tube life has ceased to be a pet discredit of radio frequency generators used on tin flow lines. To further increase the life expectancy of the oscillator tubes, new designs for radio frequency generators for tin reflow operate the tubes at a lower plate voltage and derate the output on a per tube basis.

Figure 14 shows a typical schematic diagram of a tin reflow installation. The switchgear used is of the metal-clad type and consists of an incoming line compartment with a fused disconnect switch, a main circuit breaker, a starting resistor for limiting inrush, and a starting circuit breaker for shunting the resistor under continuous line operation conditions. Power is fed to the rectifier transformers through saturable core reactors which vary the primary applied voltage. These reactors are controlled by means of an exciting a-c to d-c motor-generator set operating in conjunction with a photo-electric flow line scanner. This scanning device maintains the position of the flow line in the inductor coil within a fixed small range by causing the direct current generator to vary the excitation of the saturable reactors. Variation of the saturable reactors' output controls the output of the oscillators and therefore the power input to the strip. The auxiliary transformer supplies power to the tube filaments through an induction voltage regulator and power to auxiliaries such as pumps, blowers, etc.

Figure 15 — Diagram shows effect of frequency on characteristics of tin reflow equipment.

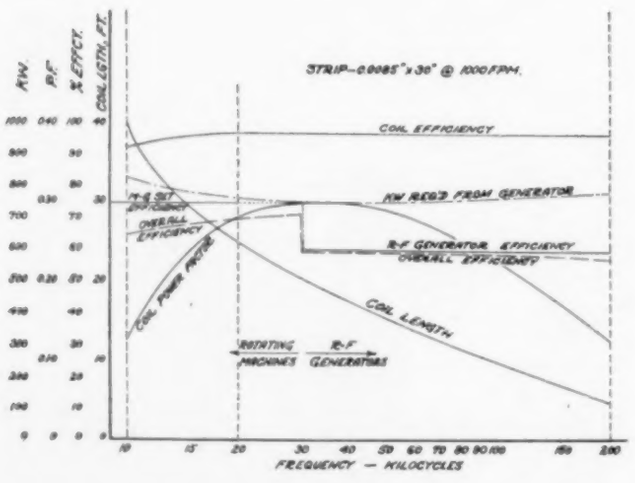


Figure 15 shows a graphic comparison of the effect of frequency on the physical and operating characteristics of tin reflow equipment. It can be seen that as the frequency considered is lessened, the coil length becomes excessive. Even though the efficiency of a high frequency motor-generator set ranges between 75 and 80 per cent at full load depending on type, compared to the 60 per cent efficiency of a radio frequency equipment, the overall efficiency of the installation is governed by the power density input to the strip. At the lower frequency of 9600 cycles, an attempt to increase power density input by decreasing coil length results in a great decrease in coil efficiency and overall efficiency. Therefore, coils of the order of four or five times greater length must be used for heating thin strip with 9600 cycles than with 200 kc if comparable overall efficiencies are to be obtained. This then means that when 9600 cycles is exclusively proposed for use on high speed

Within recent years, considerable attention has been drawn to the possible use of 9600 cycle per second power for tin reflow and other continuous strip heating processes. Induction heating of strip by 9600 cycle power does offer definite advantages in certain cases, but in certain other cases, it imposes definite disadvantages. One of the outstanding advantages of 9600 cycle power as generated by rotating machines is the comparatively low first cost of the electrical equipment — about two-thirds of the cost of radio frequency equipment of the same rating. This first cost question, however, must be considered in the light of a number of other factors, since it only covers electrical equipment expense and cannot in any way be interpreted as meaning that all other factors, in the comparison between the two methods, are the same. For instance, the inductor coil for heating at 200 kc can be five feet in effective length (that length occupied by coil turns) and about nine feet in actual length and provide an overall sixty cycle supply-to-strip efficiency of about 52 per cent when heating 0.0085 in. thick by 30 in. wide steel strip at 1000 fpm. For 9600 cycle heating at the same strip speed and size, an effective coil length of about 26 feet or an actual coil length of about 35 feet would be required to give the same overall sixty cycle supply-to-strip efficiency. If an attempt were made to lessen the 9600 cycle coil to an effective length of ten feet the efficiency would be reduced to about 20 per cent.

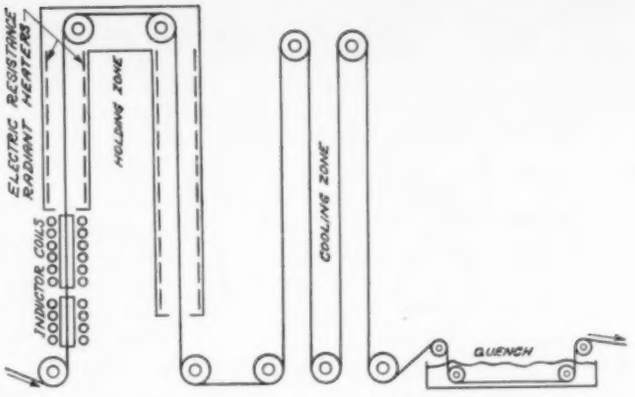


Figure 16 — The schematic diagram shows a proposed method of short cycle annealing steel strip.

tinning lines, there will result long spans of unsupported strip. This condition is not at all desirable.

One other disadvantage of the use of 9600 cycle inductor generators for supplying tin reflow power for high speed lines is that concerning the complexity of control. Such generators must work into a load of approximately unity power factor. High frequency shunt capacitors connected in parallel with the inductor coil are used for obtaining a unity power factor load. Now when the tinning line is slowed down from top speed to some lower speed for purposes of welding on a new coil of strip, or when the thickness or width of strip being processed changes, the lumped impedance of the inductor coil and work piece changes, and the power factor swings lagging or leading. In more than an equal number of cases, the power factor of the generator load will swing leading if the number of shunt capacitors is not decreased. This cannot be permitted since the inductor type generator will become self excited and control will be lost. Therefore, switching of capacitors and coil sections by means of contactors must be done or else some variable tuning element is required. In the case of radio-frequency equipment, this effect is not present and control is always present through use of the photo-electric scanner regulator system and the saturable core reactors without the need of underload switching by contactors.

The above has applied in the main to high speed or acid tinning lines. On low speed or alkali lines, there does appear to exist a place for 9600 cycle power. Particularly is this true if the greater percentage of the produced strip is of heavy tinplate gages. Also, there appears to be a very good chance for success with this type of equipment for preheating operations on lines where the final flowing is accomplished by means of radio frequency. One steel company is presently utilizing small blocks of 9600 cycle power for this purpose and another is awaiting installation of such equipment. In concluding this phase of the subject, it can be said there is certainly a place in tin reflowing and strip heating processes for 9600 cycle power; however, it is not expected that this form of heating can replace radio frequency completely for tin reflowing nor for heating of very light gage strip.

One process employing induction heating which is not being used at present but which may find its place in the steel industry in the future is that of high speed continuous short cycle annealing of tinplate. Annealing of tinplate at the present time is accomplished in coil form in several available types of furnaces. The use of a high speed short cycle annealing line would certainly conserve floor space and eliminate a considerable number of handling operations.

Figure 16 shows a schematic diagram of a line for the short cycle annealing of steel strip. Here inductor coils heat the strip to the proper annealing temperature. The strip then is held at this temperature for an appropriate length of time after which it is cooled in air or an atmosphere for a suitable time to some relatively low temperature, then it is quenched in boiling water.

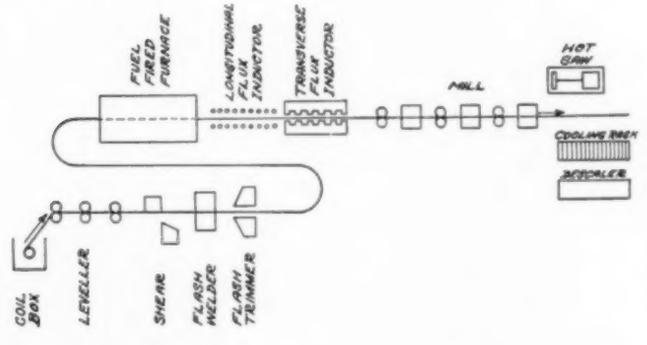
About 3600 kw of 200 kc power would be required to anneal tinplate at a speed of 1000 fpm. Controlled atmospheres may possibly be found necessary in both the induction heating zones and the resistor heating zones.

Figure 17 shows a schematic diagram of a skelp heating line. This use of induction heating could quite possibly be used in conjunction with fuel fired furnaces where it is desired to increase the speed of the mill producing pipe. Here we see that longitudinal flux heating at a suitable frequency is used to raise the temperature of the pipe skelp after it leaves the fuel fired furnace to the Curie temperature where the metal becomes non-magnetic. Then the temperature is further raised by means of transverse flux heating to a point satisfactory for effecting the weld. Proper design of the transverse flux inductor can result in accentuation of heating at the edges of the skelp where needed. Depending on the range of sizes of skelp processed, the longitudinal flux heating would be accomplished at rotating machine frequencies or radio frequency or a combination of the two. The transverse flux inductor definitely would be supplied at a rotating machine frequency.

The foregoing has certainly not covered all the possibilities for induction heating in the steel mill industry. Some others which come to mind are heating of metal prior to entry into sendzimir mills, holding at temperature and controlling freezing of molten metals, and supplying lost energy to metal between stands of a multi-stand mill. There are certain 60-cycle heating applications which may prove to be useful under favorable conditions.

The use of induction heating for the new processes outlined above will not come about overnight, but it is reasonable to believe, when surveying what already has been accomplished, that in part or whole, some of them will manifest themselves in actual installations.

Figure 17 — A proposal for using induction heating in a skelp heat line is shown in this schematic.



Budgeted Blooming Mill Maintenance

By J. H. MAYER
Assistant Superintendent
Blooming Mills Dept.
Pittsburgh Works
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

. . . . planning the maintenance program in advance will reduce delays and the attendant expenses of a mill shut-down . . . .

▲ BUDGETED blooming mill maintenance is the result of a program established in the Pittsburgh Works blooming mills of Jones & Laughlin Steel Corp. to obtain closer control of repair and maintenance expenditures. Although this paper discusses only a program for blooming mills, such a program can be successfully applied not only to all operations in the steel plant but to operations in almost any other manufacturing industry.

The title "Budgeted Maintenance" means a program established for budgeting time, materials and labor in addition to money to decrease operating delays, increase production and to obtain lower operating costs.

This idea is not a fantastic one, but based on a need for more accurate control of our costs under the present day operating conditions. In the early days of the steel industry, little thought was given to budgeting even routine manufacturing operations, let alone maintenance, but in the highly competitive markets of today with the increased emphasis on quality, quantity and economy we must take every step possible to keep maintenance in line.

In setting a budget or in initiating a program for budgeting maintenance where none now exists, consideration must be given to several factors:

First, a complete analysis of the general condition of the mills and auxiliary equipment must be known in order to determine the proper amounts of time, material and money to be allocated to each unit to maintain a good operating plant. This, it is felt, can best be done by the department head together with the individual mill foremen. Often separating an entire unit into smaller sections assists in such analysis. After each section is reviewed as to the condition and noted, there will be available the complete status of the units and the sequence in which time, material and money can best be allocated to bring the entire unit to a point wherein it can operate most efficiently. Such an analysis should be made approximately every three months in order that at all times the exact conditions of the equipment are known. It is also necessary to have such information to budget for the following quarter and the following year.

Second, the life expectancy of the various parts that go to make up such a unit should be established. With such life expectancy known and barring unforeseen or undue breakage, it is possible to budget well into the future for both replacements and spares. In initiating for the first time a budgeted maintenance program, this life expectancy or replacement schedule will be based on some past experiences and knowledge of happenings by persons that have been familiar with conditions of the department for some time past. It may prove shocking to find that some pieces are failing too often, but inasmuch as no analysis had been made in the past, the frequency of such failures had gone unnoticed.

To accurately budget for replacements, no longer can the memory of past experiences be relied upon. Good budgeting of materials must be made from sound records. A physical inventory must be kept of all spare equipment. Such an inventory must be recorded piece by piece. Recording can be made by use of a card file system of your own origin or chosen from one of the many now on the market. Such a filing system must readily make available all necessary information, such as name of piece; the particular unit on which it is used; the particular section of each unit the piece fits to or with; specifications, weights, costs, etc.

The filing system we use is simple in its operation and

Figure 1 — A card is set up for each item as it appears in the inventory.

JONES & LAUGHLIN STEEL CORPORATION
SOUTH SIDE WORKS
REPORT OF SPARES USED

DEPARTMENT 44" Blooming Mill DATE 7-20-48

Order Number	Quantity	Description	When Used	Stock on Hand	Account Number	Cost
	4	Steel Bushings PC-218	Roll Table	4		
	1	Timken Bearing 99400 44102	Main Mill Table	4	Held in Tool Room	
	1	Hyatt Bearing W-230	Roll Table	4	Held in Tool Room	
	2	Bot. Bushing A-23343-C	Roll Table	12		
	1	Bot. Collar A-23343-D	Roll Table	12		
	1	C.S. Gear A-20458-D	Main Mill Table	1	Order - 4	
	1	C.S. Insert A-23343-J	Roll Table	12		
	2	Sets of Std. Slippers				
		16" OD A-23327-E	Spindles	6	Rush Order B.M. 2162	

John McLaine Foreman

contains a card for each item as inventoried. It operates as follows:

1. Each item is recorded as ordered and noted as received, with date, name of vendor or vendors, costs and most important where it is stored so that it can be located quickly in an emergency. See Figure 1.
2. Each item is charged out as placed in service together with date of installation. See Figure 2.
3. As soon as it is taken from service, the date is recorded, and life realized or the service to date of the piece shown.
4. The reason for removal or replacement is recorded.

From this information a schedule for purchasing spares or making replacements can readily be set and a budget allowance made accurately.

Such a control will not only aid in establishing a budget, but by knowing in advance the life expectancy of a part, replacement schedules can often be set thus reducing breakdown failures together with the ultimate maintenance cost.

In addition, an analysis can be made from this record of the life of each piece with a view towards improving its useful life by changing specifications, lubrication requirement or making whatever correction can be made to eliminate the cause of failure. Such information is often valuable when planning for modernization or replacement of equipment.

Supplementing this filing system and record kept on spares, it is also desirable to keep a record of breakdowns — listing the causes of failure, the particular parts replaced, any unusual conditions that were encountered in the repair job, and any other information which may be useful on future repairs. After production has again started, a careful investigation or analysis is made to determine the reason for failure, materials used, manpower necessary and costs involved; all of which is carefully recorded and filed for future information, and a preparation made for better handling, if and when that particular breakdown or a similar one should occur again.

Another factor for which we must give consideration in budgeting for maintenance is the designated inspection periods for each section of mill units. It is very easy to see those parts that are exposed at all times during operations, but at regular periods, each section should be opened for inside observation. In a unit as large as a blooming mill, there are many places to be inspected, and time and men must be carefully budgeted for this work. It is usually done during scheduled down times to allow a maximum of time for any repair work. Records of such inspections will also help to determine the possible life expectancy obtainable, and time to be allocated in the near or distant future for proper replacement.

Spares material in storage also must have a portion of the budgeted inspection time. The actual procurement of materials alone will not prevent troubles in times of failure. Many pieces kept in storage for production protection are not used for several years. During this time, rust, mishandling, dirt, etc., will make this piece of material useless and cause further delay in repairing or replacing a damaged portion if there is poor storage and no inspection.

In budgeting, the final expression of all this will be a dollar value, so it is necessary to relate the quantities of men and materials and the amount of time to money. Therefore, in setting a value on the requirements, the previous year's costs, or the average of three years, or possibly the best year's costs of the three for the individual units is used as a guide post. Together with this, the analysis of the overall condition of the equipment and the long range repairs that are planned, the spares which will be needed for routine replacement of parts, the labor required for periodic inspection, enables us to set a dollar budget that we can reasonably expect to meet.

Probably the greatest difficulty in setting a maintenance budget is to determine an allowance for unusual expenses and contingencies. No one can anticipate in advance what particular failures might be encountered in any given year, let alone set a dollar figure as to their yearly cost. However, a careful analysis of past expenditures and a record of the various breakdowns in the past is a good start towards setting a reasonable allowance for such costs. Furthermore, periodic review

JONES AND LAUGHLIN STEEL CORPORATION & SUBSIDIARIES

RECORD OF SPARES—LOCATION:

PAT. OR MARK NO. A 23326-A | DRG. NO. A23326 | WEIGHT OF ONE 28500 LBS

NAME Mill Spindle #12 | WHERE USED Spindles | NO. IN USE 2

DATE	REFERENCE	QUAN. RECEIVED	QUAN. ISSUED	BALANCE	PRICE	AMOUNT	SERVICE RECORD: DATE IN	SERVICE RECORD: DATE OUT	SERVICE RECORD: TONS ROLLED	REMARKS AND DISPOSITION
6-19-46	Req 5993	1	1-9-47	—	$13,600.00		9-7-47	2-21-48	625,000	Spindle was bought complete with heads & Slippers fit & assembled from Merta Mach.
	15028									
	17519									
2-21-48	B-5790	1 from	2-10-49	—			2-10-49	4-11-49	250,000	pressed to strip & fit new small head & Slippers
6-11-49	B-2836	1 from								fit small Slippers and check small end head

CAT. OR STOCK NO. A 23326-A | NAME Spindle - # 12 | WHERE USED Spindles

Figure 2 — This card gives a record of the spares used on each particular unit.

of performances, such as every quarter, give ample opportunity to review and revise where necessary. These revisions are not just a loosening of the budget, but represent a rearrangement of the allowances to be spent to enable us to maintain the best possible physical plant for the money spent.

Finally, a brief mention of what can be done to adhere to a budget.

Adherence to a budget can be accomplished by a close analysis of expenditures on the individual units and periodic conferences for review of the department foremen to eliminate those losses due to neglect, improper planning and the use of wrong material. These conferences can also be used as training meeting to acquaint the men with the latest techniques and recent developments in maintenance practices. Concentration on salvage programs to reduce wastes and to rehabilitate used parts capable of many hours of useful life represent savings over scrapping and purchase of new equipment. These are all ways to bring about an improved budget performance and reduce maintenance costs generally.

However, we must remember that, even though we have set up a budget, and make every effort to adhere to it, unforeseen conditions, or unusual breakdowns may occur that will require expenditures over that allowed in the budget. In such cases, these expenditures should be made as we cannot sacrifice the condition of the equipment to meet a budget. The ultimate costs of neglect are high.

In conclusion, may I say that budgeting of maintenance work, although it may be more difficult than routine production work, can be done. We have done it. It is succeeding and we believe we will continue to benefit from such a program.

DISCUSSION

PRESENTED BY

J. H. MAYER, Assistant Superintendent, Blooming Mills Department, Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

J. R. CHEGWIDDEN, Superintendent Mills, Bethlehem Steel Co., Bethlehem, Pa.

G. J. WALZ, Superintendent of Electrical Department, Bethlehem Steel Co., Steelton, Pa.

CHARLES C. MacDONALD, Assistant to Works Auditor, International Harvester Co., Wisconsin Steel Works, Chicago, Ill.

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

Member: At our plant for the last twenty years, we have been working on a system similar to the one you explained, and by controlling maintenance repair hours or shop hours according to tonnage produced by units, the shops are informed of estimated monthly tonnage of units. We use the card system showing all information and history of each individual part. There, again, we use the card system, but you run into difficulties with fellows not reporting properly. We record delays daily and monthly.

The mills are scheduled on a one turn down weekly basis, and in that time we plan our repairs and make regular routine inspections. It is a very important part, and I noticed, in your paper, there is a periodic meeting with the individual foremen on program and hours and planning the necessary work. On this system, our experience has been that one of our biggest troubles is that we cannot get all the proper information in. I would like to know how you get the information from the individual men so you can keep your records up-to-date.

J. H. Mayer: I think that it is necessary that your budget should conform to your tonnage. We believe that, with a mill with lesser production, it will certainly wear out in a longer period of time, and I believe it should be worked out in conjunction with your tonnage production.

Getting accurate reports of spares used has been a long, hard battle. It was one of years. I may make one suggestion that may help to solve that problem. I am a firm believer in enthusiasm, whether it is at play or work, and I believe that you can get your mill foreman to be enthusiastic about the importance of knowing whether or not they have a proper spare; that the neglect of charging the spares out as used will certainly be a detriment sometime. You all know that has happened. Place upon his shoulders the responsibility that it is his job to see that such reports get in. In times of difficulty, when spares are not on hand, that your main office card-system says are there in the designated space that they should be, it causes longer delay time. The foreman must accept this responsibility. Too often, the larger spares will not be located on stand adjacent to the mill. Because of this, they can be moved, or new material delivered without his knowledge. The smaller spares, located at the mill unit, are easily enough located as they are stored in the so-called millwright shanties, electrical shanties, and so forth. If he will also make a plan for himself, that today one crew will count items and the next crew will count so many more, your chances of being without proper spares is small. I must tell you about one particular foreman we have. He is very clever and enthusiastic. He has a little notebook, and each particular bin in every shanty has a date to be recounted so he cannot get into trouble.

J. R. Chegwidden: How can we compensate for a stepped-up schedule?

J. H. Mayer: I rather think — and this is not hedging the question — that will pretty much take care of itself. If you have regular down turns and you have a good, well-planned inspection program; one that is not slipshod and one that really has a lot of thinking behind it, a lot of planning, that will periodically open up each and every part of that mill, you will pretty much know just exactly where your weak points are developing. A lot of weak points in mills develop from looseness here and there that you can pick up ahead of time, or possibly something that is getting a little too much wear in it that may, in a short period of time eventually get so bad that it breaks because of the looseness and the wear. I feel that when your mill is under heavy production, and the records prove this, you seemingly have less breakdowns than you had before when your mills were working on a more or less slacked-up schedule. Seemingly, every time we get a

busy spell, we have a lot less trouble. Why it is, I do not know, whether it is because the men are keyed up to turn out heavy production schedules and watch their mill a little more closely, or maybe due to the enthusiasm of the foreman on the mill. He recognizes he has a heavy schedule ahead of him, and he puts that enthusiasm into the men to keep it going.

G. J. Walz: Have you money appropriated for the electrical department?

J. H. Mayer: Yes, you cannot neglect any portion—and I do not believe there is an exception to the rule—of your maintenance, whether it be electrical or mechanical. The reason you do not see it noted up on the form we had there is for the simple reason that electrical work applied to the individual sections of the mill, the tables, houses, manipulators, and so forth, is chargeable direct to that unit, with the exception of motor repair. I think you are only interested in the fact that certain portions of the mill constitute so much money in setting up a budget. Unless you know the portions of the mill that cost most, they will probably get the least, and the portions needing the least will get the most. However, we try not to slight any particular phase of our maintenance.

Charles C. MacDonald: Is your system plant-wide, and do you have any rule-of-thumb as to how far you break down classification of equipment?

J. H. Mayer: This system was pretty much a forerunner. The blooming mill was most fortunate in starting the system. We started it probably about 1937 or 1938, and three years ago we had a tremendous fire in our office, which was quite an old building. We rebuilt, of course, but lost the records. It really was heartbreaking that morning when we looked at the results of the fire, and there was the card system with approximately 66,000 cards with records of about five or six years piled up in them. If you do not think that is heartbreaking, set yours on fire sometime.

Your question concerning a rule-of-thumb classification of the pieces of the mill, and how we control the spares in a central or local storage, I think I can best explain that in this way. If you talk to a dozen men, you will get a dozen different viewpoints. However, I will give you mine, having been a maintenance man for some six or seven years in the maintenance department. There has been some considerable talk from time to time of centralized storage of spares. Every time they do, I quiver. I think it is a maintenance foreman's responsibility to have the spares he needs. I do not believe we can shirk that responsibility any longer. I have always felt — and this is personal thinking — the minute you have a centralized spare yard, and you have a supervisor of a central spares yard, he cannot be interested in any one department. He must take into account all of them. However, he has a divided interest, and to you, your spares are most important. You must keep that mill going.

I personally am in favor of your local storage yards, with the exception of those items like your standard crane wheels and crane derricks, drums, and things of that nature, your standard motors, where, from a centralized point, it is foolish for each one to carry ten or fifteen brake-wheels or track-wheels, and so on. However, it certainly makes your heart feel good when your mill does down and you have a spare ready.

Louis F. Coffin: The prime purpose of maintenance is to keep the mills operating, and while budget and repair costs are of importance, the first consideration is to have a satisfactory operating mill with adequate spare parts production that will produce high tons-per-hour at a high yield. If you have such a mill, you will have a low repair cost.

It is our practice at Sparrows Point, and has been for many years, to list all spares on cards with material specifications, quantity on hand and on order, and also to list uses. The greatest difficulty is to be sure you get all the uses reported as most spares are not stored in locked store houses. Steel plant management is recognizing the need for proper facilities for this purpose.

It is also important to follow intelligently and systematically the material specifications and heat treatments and the detail design of parts so that we may realize the ultimate in long life and in reduced maintenance. The purchase of all new equipment presents the opportunity for the maximum of cooperation between engineering and maintenance supervision to achieve the correct result at the start.

Charles E. Pritchard: It is quite gratifying to see that the trend in maintenance control in the steel industry has included the operators. For some reason or other, in the past, maintenance costs have been purely the responsibility of the maintenance people. It should not be. Maintenance costs are a dominant factor in operating costs and should be treated as such. It is quite important to see that the operating costs also include mechanical, electrical, and associate maintenance costs and that actual programs are instituted to make everybody concerned cognizant of their relative importance in holding the operating costs within reasonable limits.

I would like to ask Mr. Mayer a couple of questions regarding individual responsibilities in carrying out a program of this type. To whom is the responsibility allocated for coordinating this program?

You also mentioned routine inspections in your paper, and I would like to know a little more about how you go through the process of bringing these inspections to bear on the immediate subject. By that I mean, who actually performs these inspections; how are they coordinated from the standpoint of mechanical and electrical maintenance and then tied in with the respective operating schedules? Who actually coordinates the daily recordings covered by these inspections and carries out the scheduling of the necessary maintenance in the time allotted during the mill down period. Accessibility of spares has been quite a considerable maintenance problem in the steel industry, due primarily to space limitations in the operating departments. In our own organization we found it mandatory to set up one or more so-called central spares yards under the direction of a given man complete with a card index system covering all those spares that are not classified as routine spares. The duties allocated to the spares yard supervisor include tabulating receival of all spares, properly preparing all machined surfaces with the correct type anti-rust compound, storing of the spares by department in such a manner as to permit ready access when needed, and tabulate removal of the spare from the yard for service in the respective department. The routine spares are stored in the

proximity of the actual point of usage. A program has been set up to insure all such routine spares being properly rust-proofed at the service shop before transfer to departmental storage. The benefits of this program have been many and far reaching in making available to the maintenance forces a spare with all machined surfaces in a usable condition as installed, plus provision of a definite control over spares inventory at all times.

J. H. Mayer: The departmental superintendent should certainly be responsible for the costs of his department. I think, of course, that your master mechanic, or whatever you may call him in your maintenance department should prepare the necessary budget. Usually the department superintendent is not just as familiar with the ins and outs, even though at some time or other he may have graduated from the mechanical division. He is not as close as the master mechanic to the needs and requirements and changes of times and new types of materials, specifications, and whatnot.

Inspection starts off with your department head and your mechanical division setting up a definite program of inspection of each and every portion of the mill, not slighting any one individual piece or place. Of course, it is impossible for him to see that each item has been checked as the days, weeks and months go by.

Another thing that Mr. Pritchard brought up was weather-proofing the material before shipment. I am heartily in accord with that and very sympathetic. Our shops are very small, and for the last five years, we have tried to put across a program that all finished surfaces would be weather-protected before they leave the shop. During transportation by railroad or other means, they get sidetracked and stay out over-night, or possibly for a day or two before they get into the storage yard, and it rains on them; they get a small coating of oxidation, and that is the start of trouble. The roller bearings should be wrapped, and every machine surface should be weather-protected. Such being the case, you will have gained a lot, and it can be accomplished at a lesser cost.

If your spare yard is of any size, the spare-yard attendant should be responsible for all the spares in the yard as to safe piling. If not carefully watched, spare yards will become unsafe with the rollers and shafting and all the unusual shapes and lengths. The spare-yard attendant must report the movement of spares in or out of the yard, and who should also see that periodic weather-protection is applied.

Last year we completed a new mill, but before the mill was completed, and during the engineering stages — and let me stress this point — during the engineering of any new mill, whether it be small or large, whether built in your own shops, or by contract to one of the machinery manufacturers, step by step, your maintenance man and your mill foreman should get a pretty good look at it, as such a plan will go a long way in having a unit that is sturdy and will eliminate a lot of the "hard to get to" places.

One of the most important things that affect your operating costs is the fact that you have some weak places in your mill units that fail frequently. You wonder why the man on the drawing board ever designed such a piece of machinery, when you now realize it could have been made more efficient and more accessible.

As the design moves along, all of you, and certainly your mill foremen, have good ideas what will most likely fail. Your experience points out the vulnerable points, and so as it progresses, you should pick up those weak points and prepare for them. When the mill starts operation, those spares should be on hand. You would not start your mill up without a spare set of rolls. By the same token, you would not start it up without a spare set of spindles.

Management wants to cut costs. With a budgeted plan operating, and should you need a piece of equipment, as I pointed out in the paper this morning, certainly the most costly part of operations would be to not have sufficient spares to practically operate your mill. Your downtimes then will be high because of spares not being available. If you can show by actual records and experience, that certain spares are needed, I hope that management will not restrict you from that operation.

On the subject of cooperation, the operating superintendent must certainly cooperate and see to it that the proper moneys are allocated at the request of your departmental heads. Otherwise you will find that you are in dire straits. You must be well acquainted with all needs from time to time.

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HOTEL STATLER APRIL 30, MAY 1, 1951

THE MECHANISM OF MATERIAL HANDLING

By C. WHITEFORD
Manager, Material Handling Engineering
Ford Motor Co.
Dearborn, Mich.

. . . . appreciable production savings can be attained when the right materials handling setup is established . . . .

▲ MATERIAL handling engineering and associated activities, the subject of this paper is broken down as follows:

1. What recognition has Ford management given to material handling engineering and operations.
2. What type of organization and responsibilities have been set up and assigned.
3. What procedure do we follow in analyzing a material handling problem for better methods and installation of modern equipment.

The mechanism of material handling and facility specification is a broad subject, so these comments will be confined to its relation to the handling of iron and steel.

The variety and combination of production methods is unlimited. Basically, production operations consist of receiving and processing raw materials, or performing an operation on the stock which enhances its value.

The movement of materials or stock to and from productive operations is called material handling. The development of standards for handling methods, design of equipment and containers, for the transportation, storage and handling of materials, is material handling engineering. It is the mechanism of this phase of material handling and facility specification that will be covered.

Industrial executives should be encouraged to realize the need for a broad material handling organization and program that cuts across all operational functions. The responsibility for carrying out this program must also be fixed at the management level.

Progressive management considers material handling as an essential item in engineering for production. Progressive management places material handling on an equal footing with plant layout, manufacturing research, production engineering, production analysis and industrial engineering, in such a manner as to insure maximum cooperation between all elements of the team which engineers for production. In such an organization, material handling is not required to try to fit modern material handling equipment and methods into a predetermined plan. It participates in the initial basis planning, both for new facilities, and in the improvement and rearrangement of present operations.

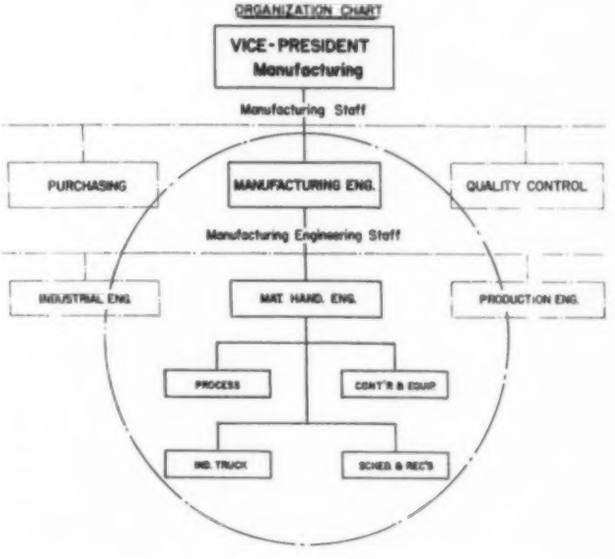
We have analyzed the various phases of our manufacturing costs and learned that from *20 to 25 per cent of our total production labor cost is for handling materials*. We have learned further, that while steel manufacturing methods have improved tremendously in the last twenty years, there has not been a comparable increase in material handling efficiency. The savings realized by more efficient production methods may be more than nullified by a resulting increase in material handling costs, unless the whole job is carefully coordinated.

Material flow, in measured volume, should be flowcharted to reveal bottlenecks. Bottlenecks may be merely underfacilitized operation. They may be underfacilitized in several ways: equipment, floor space, labor or organization. These bottlenecks must be recognized, and conclusive plans made to equalize the job with the necessary facility. It may require more equipment, more floor space, more labor or more supervision.

The cost of handling *goes up*, and effective servicing of production activities is *lowered*, as the capacity of the handling facility is overloaded.

Our experience has convinced us that the extent of saving potential in this field of integrated material handling operations, warrants the adoption of a consistent approach to the problems of reducing indirect material handling costs. Management cannot discharge

Figure 1 — The organizational setup for a materials handling engineering group is given in this diagram.



its responsibilities for the development of this technique, by merely installing a few more machines, or pieces of equipment.

Figure 1 shows a good example of organizational positioning for material handling engineering. Note that, organizationally, *material handling engineering is at the policy-determining-level,* along with all other activities which are concerned with engineering production for the company.

The internal organization of a material handling engineering department will depend largely on the personnel required to fulfill the departmental responsibilities. The chart merely shows a logical breakdown. Many others are possible. More important is the definition of the departmental responsibilities.

Material handling engineering is just one part of the team which engineers for productions. (At Ford we call it manufacturing engineering.) Manufacturing engineering determines policy in the production field. It establishes manufacturing methods and standards; studies present policies, procedures and plants; and recommends to management changes for more efficient operation. It formulates manufacturing plans for the years to come, referred to as forward programming. Material handling engineering must accept its part of that task.

The following items are a fair statement of a material handling engineering department's responsibilities:

1. Plan and direct material handling engineering activities in accordance with broad specifications outlined by general management.
2. Functionally supervise all material handling engineering activities throughout the Ford Motor Co.
3. Review and make recommendations pertaining to material handling layouts, facilities and standards on project requests which require manufacturing staff office approval.
4. Design, develop and specify company standards for containerization, packaging, special railroad and transportation handling equipment.
5. Establish standards and procedures covering operations and maintenance and modification of powered handling equipment.
6. Keep abreast of current developments and research in the material handling field to determine applicability to Ford Motor Co. operations.

Note that the first two and last responsibilities listed are general and apply equally well to any staff departments.

The third, fourth and fifth responsibilities we assigned to separate sections: the processing section, the equipment and container development section, and the industrial powered handling and transportation equipment section, respectively. To coordinate section activities, to provide office services, budget control, standard departmental practices, a scheduling and records section was organized. With these four sections, assignments are broken down to a point where the engineers can do a great deal more specialization resulting in better performance.

As mentioned before, depending on the size of the company, the complexity of its organization and the extent of the material handling engineering staff responsibility, it may be desirable to combine two or more of the responsibilities or have the engineers answer directly to the department head. That is a local problem that can be answered only after a review of particular needs.

Figure 2 shows the position which division and plant material handling engineering personnel should occupy. If the company has but one manufacturing division operating several plants, it might be well to consider this chart in its entirety. For single plant operations, the organization indicated on the lower part of the slide is recommended. In each case, staff determines policy at its organizational level and applies policy, established at higher organizational levels. The same rule applies to the development of standards, procedures and other staff functions.

But all this does not give personnel to handle material. We have only established working guides and rules. The actual handling of material must be done at the operating level. The principles established must be applied by people on the job. In operations, we have the ultimate application of policy, also the adaptation of standards and development to specific local needs that require on-the-job practical engineering. Here, operations have the benefit of staff assistance and help, when ordinary application of guiding principles, will not solve a complex problem.

With all these components, you have an ideal team, engineering to assist in showing the way, and operatings to do the job.

It should not be necessary to point out that a small initial program, well planned and prepared, is of much more value than an ill-advised, extensive program.

Recent changes in steel prices, partially due to packaging extras, have produced several problems that pertain to steel handling and storage practices. Previously, the greater portion of wrapping and banding costs were included in the quoted cost per ton. Bundles over 10,000 lb are more economical from a packaging standpoint. This fact makes it imperative that we restudy our complete handling facilities to take advantage of lower prices. Consequently, we are establishing

Figure 2 — Materials handling engineering is a staff function.

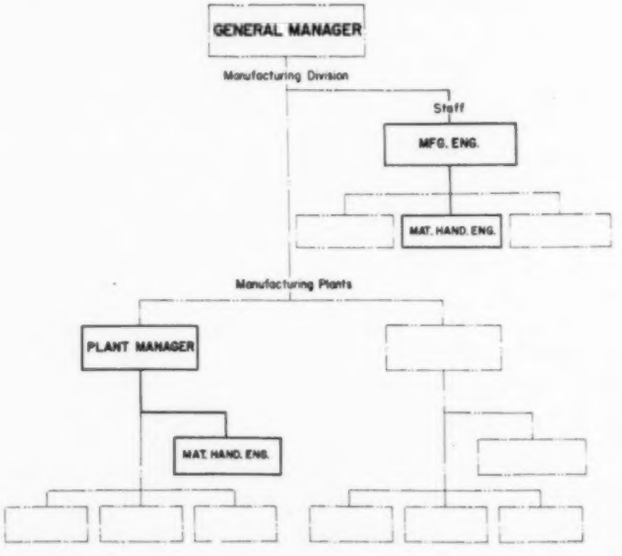


Figure 3 — Materials handling with locomotive crane requires expensive equipment and track layouts.

steel skidding, wrapping and shipping standards for use by operations.

It is the responsibility of operating people to apply the bundling standards and write specifications for their particular bundling requirements. The standards are guides; call them tools if you wish, which must be utilized by the operating people in the successful performance of their day-to-day jobs.

You cannot afford to spend a dollar to protect a fifty-cent item, nor can you condone damage to a $100.00 item for the sake of a fifty-cent expenditure.

Steel operations in conjunction with manufacturing staff have recently completed a survey of all phases of our steel production methods and operations. A complete report which embodied a number of proposals for method changes and plant rearrangements was submitted to management.

One of the operations studied, which offered a definite challenge for improvement, was the handling and storing of bundled frame steel produced in our mill. Our rolling mill operations are somewhat handicapped by inadequate handling and storage areas.

The problem involved the daily transportation of 560 tons of bundled frame steel from the rolling mill to the frame manufacturing building, approximately ½ mile distance. Thirty per cent of this steel was delivered directly to the building with the balance to various outdoor yard storage areas and locations.

TABLE I

Excessive Cost Factors

Equipment	Cause	Result
Rolling mill building crane	Insufficient capacity.	Car loading delay congestion reducing production of flying shear. Excess handling.
Locomotive and locomotive crane	High operating cost. Restricted area. Delayed switching.	Excess handling. Restricts storage. Loading delays.
Frame building crane	Insufficient capacity. High operating cost.	Loading delays. Production delays. Excess handling.
Highway truck	High operating cost.	Excess handling cost.

An analysis of the operations showed the following factors contributing to excessive costs (Table I):

Figure 3 pictures a typical example of high operating cost resulting from the type of handling equipment, restricted storage area and excessive handlers required.

In approaching the problem, the first step was to compile a complete list of steel sizes, volumes, weights involved, taking into consideration future anticipated production schedules, etc.

In conjunction with the operating personnel and other staff departments affected, improved handling methods and storage locations were considered. Several proposed methods included the integrated use of locomotive or truck crane, automotive truck tractors and lowboy trailers, industrial tractors and trailer trains, serviced by industrial fork trucks. Careful consideration and cost analysis was made for each proposed method, and discarded when found to be impractical or too costly to warrant further consideration.

A further study establishing an outdoor storage area, adjacent to the frame manufacturing building and the combined use of a trailer train and straddle truck handling method showed definite saving possibilities with low initial cost for handling equipment.

The specified straddle type pneumatic tired truck incorporates the advantage of both conventional steel carrier and straddle type truck. See Figure 4. This combined engineering provides a pneumatic tired heavy duty unit for outdoor operations with horizontal adjustable hooks and the ability to tier to a height of 80-in. from floor to top of tier.

Consideration of the proposed use of trailer trains

Figure 4 — The carrier truck is finding many increased applications in steel plant materials handling.

Figure 5 — Trailer trains have the advantage that track layouts are not required.

(Figure 5) and straddle truck to replace railroad switching necessitated a comparative analysis of all equipment and material handling costs involved, for management to determine its practicability and render a decision for its acceptance or rejection.

A specific procedure for a cost analysis, with standard forms, is generally used for comparing present versus proposed methods. Analytical forms have been developed to assist in the summarization of material handling costs and are shown in Tables II, III, IV.

Table II—Material Handling Cost Summarization Form summarizes, under headings "Present" and "Proposed," the total handling equipment cost per ton as posted from detailed analysis forms prepared for each method.

The Operation Analysis Form, checked as either present or proposed, is completely filled out, one for each operation performed, such as load, unload, transport, etc., and is based on estimates or established labor standards.

The Operating Expense Analysis Form is used to list and segregate all operating expenses such as dunnage, banding material, wrapping, skids, industrial equipment, gas, oil, maintenance, freight, etc. These can be summarized on the form headed Operating Expense Summary. Operating Expense Summary reduces necessity for submitting unnecessary and confusing bulky detail.

The Depreciable Facility and Equipment Analysis is used to itemize depreciation cost per unit of material handled at normal rate based on actual hours used. A typical example of the type of operating analysis and detail required on proposed frame steel handling method is shown in Table III.

This is an analysis of the present and proposed transportation methods for the foregoing problem of handling frame steel. It shows the locomotive time to be 140.96 min. or 23 per cent of the present overall material handling cost. Under the proposed method the industrial tow tractor trailer train is used 1440 minutes but represents only 13 per cent of the present overall cost. A reduction of 10 per cent in the present cost of this operation is shown to be possible.

These figures, in percentages are posted to the summary sheet.

Table IV—Material Handling Summarization gives a comparison of costs under both methods, depicting a net reduction of 53 per cent in material handling costs for items shown by proposed method.

Operating expense, depreciation, etc., analyzed in

TABLE II

MATERIAL HANDLING ANALYSIS

Present Proposed

MATERIAL HANDLING COST SUMMARIZATION

1. Labor: 2. Operating Expense: 3. Depreciable facility & Equipment

Loss
Potential Saving.....

OPERATION ANALYSIS

Cycle of Elements of Operation

OPERATING EXPENSE ANALYSIS

OPERATING EXPENSE SUMMARY

Expense Material: Miscellaneous Expense: Shipping Cost:

DEPRECIABLE FACILITY EQUIPMENT ANALYSIS

TABLE III

OPERATION ANALYSIS

TRANSPORTATION (PRESENT)
CYCLE OF ELEMENTS OF OPERATION

NO.		MIN/DAY
1.	SWITCH FROM ROLL MILL — 12 CARS @ 9.5 CARS AVERAGE PER SWITCH = 1.263 SWITCHES PER DAY @ 43.2 MIN. EA.	54.56
2.	SWITCH INTO BUILDING — 4 CARS @ 2 CARS PER SWITCH AVERAGE = 2 SWITCHES PER DAY @ 43.2 MIN. EA.	86.40
	TOTAL MIN. PER DAY	140.96
	PER CENT OF PRESENT COST	23

TRANSPORTATION (PROPOSED)

NO.		MIN/DAY
1.	TOW TRACTOR HAUL MILL TO YARD STORAGE AREA — 3 SHIFT OPERATION	1440
	PER CENT OF PRESENT COST	13

TABLE IV

MATERIAL HANDLING

COST SUMMARIZATION

COST PRESENT METHOD = 100 PER CENT

	PRESENT	PROPOSED
	PER CENT OF PRESENT COST	PER CENT OF PRESENT COST
1. HAUL FROM ROLL MILL TO YARD AND BUILDING	23	13
R. M. CRANE LOAD CARS OR TRAILERS	16	10
LOCOMOTIVE CRANE OR CARRIER UNLOAD IN YARD	35	7
HIGHWAY TRUCK OR CARRIER HAUL TO BUILDING	9	7
F.B. CRANE — UNLOAD CARS, TRUCK OR TRAILERS	17	10
TOTAL	100	47

the same manner, and computed in dollars and cents, show the potential loss or saving of the present versus the proposed method.

Close coordination with operations and other departments involved, such as plant engineering and plant layout resulted in their concurrence with the proposed method for handling frame steel and potential savings, as shown on material handling engineering cost analysis. A proposal was then submitted to management for their review and decision as to its adoption or rejection.

Most everyone can remember one or more proposals which in your mind were sound, but which management would not accept. You have probably asked yourself, "Why does management pass up these ideas?" and have said, "I know the proposal will work, and it will reduce costs or improve operations, or both." It is a disappointment when your recommendations do not get that very important signature in the space headed "Approved." Generally, management can see a lot more of the problem, and we have either failed to consider all of the factors, or have failed to *present our proposal properly*.

These are the important factors to be considered in each decision:

1. What is the present method, and what operations are included?
2. What are the advantages and disadvantages of the present method?
3. What changes are proposed—and what alternative methods or equipment might be used?
4. What advantages will be gained, i.e., reduction in costs or improvement in operations?
5. What are the disadvantages of the proposed change?
6. Will the proposed change be effective for a limited period only, or will it serve future production; will it be more, equally, or less effective for further production?
7. How will it affect other steps in production?
8. What are the economics of the proposal?

All of these questions are important—unless they are satisfactorily answered, management cannot make a sound decision. The answers to all of them will vary considerably, and the method of presentation will also vary with each proposal.

Everyone has seen or heard of instances where substantial amounts of money were spent and the savings did not materialize. No business can absorb many mistakes of this kind. Material handling engineers and operations have an important responsibility in making recommendations; their recommendations must be practical and they must be sound.

USE OF MAGNETITE ORES FROM NEW YORK*

▲ NEW YORK State sinter is more economical to use than Lake Superior iron ore in the blast furnaces at Warren, Ohio.

The sinter—iron ore from which impurities have been removed by grinding and screening and which is formed into lumps by subsequent heating—is high quality and contains so little refuse that an appreciable saving in freight is realized. Meanwhile, the increase in cost and decrease in quality of Lake Superior ore delivered at the Warren furnaces makes the New York sinter the more desirable.

The old iron mine at Port Henry, New York, active in the Revolutionary War era, is typical of operations in the reopened Adirondack Mountain deposits. Mining takes place underground, the lowest level now being worked is approximately 2,300 ft below the surface.

As the demand for pig iron becomes greater each year, further development and utilization of this body of ore is of paramount importance for the immediate future.

*Abstracted from paper of same title presented by K. G. LeViseur, Superintendent, Blast Furnaces, Warren District, Republic Steel Corp., at Pittsburgh Regional Technical Meeting of AISI, October 11, 1950.

CONSTRUCTION AND MAINTENANCE of Open Hearth Furnace Bottoms

. . . . best results in maintaining the open hearth will be accomplished only when furnace personnel are properly trained . . . . perhaps first-helping should be made an apprenticeable trade . . . .

By C. W. CONN
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▲ SINCE the advent of basic open hearth furnaces in steelmaking, the method of installing furnace bottoms changed very little up until the World War I period, when the supply of Austrian magnesite became limited. Prior to this time some dolomite and lime were used, but generally speaking, the conventional bottom was installed with Austrian magnesite using basic open hearth slag as a bond.

Solid concrete piers made a foundation in the early period, topped with several courses of red brick, up to a point where clay bricks were used. The rough contours of the hearth were shaped with clay brick and faced with magnesite brick. Then the hearth was completed with from 12 to 27 in. of grain magnesite burned in.

During the shortage of magnesite brick, chrome brick was used as a substitute in bottoms, and time proved that the chrome brick did not disintegrate as did the magnesite brick. So, from 1920 onward, more chrome bricks have been used in bottom installations. It was a common practice to use a slag wash over the brickwork in the hearth before starting to burn in the grain magnesite to take care of the joints and to make the subhearth as monolithic as possible. Later, magnesite mixes were rammed in and chrome ore mixes applied, until a plastic chrome hearth refractory was developed for this purpose. This has been used extensively since 1929. When the furnace is brought up to temperature, this plastic chrome ore is burned to a monolithic state and forms the base for the grain magnesite. As pan bottoms were installed, the thickness of refractory materials was gradually cut down to a minimum.

No further great change in the method of bottom construction took place until 1939, when the cold ramming, high magnesia refractory was introduced as a unique material for new hearth construction, and for major repairs to bottoms and banks. It has completely revolutionized hearth building practice in the basic steel industry. These materials have proven to be thoroughly dependable, uniform in quality, and easy to work with. They make a hearth that is highly slag-resistant, easy to maintain in sound, clean condition at minimum expense, and which is extremely resistant to hydration. The greatest appeal of these materials is the substantial saving in time effected in hearth construction. The hearth material is merely tempered with water and cold-rammed behind forms over the brickwork, thus establishing any bottom or bank contours desired.

The ramming operation requires only a matter of hours, even in a large open hearth furnace. The refractory takes a firm air set, and when the furnace is brought up to normal operating temperature, a strong ceramic bond is developed. The tedious work of burning in layer upon layer of grain magnesite is eliminated, and there is a time saving of as much as a week or more in completing the hearth. Roof and wall refractories are saved the severe strain of burning in temperatures. A variety of practices have been successful. Some operators have installed fully rammed hearths with no other working surface. Some have used the ramming material as a sub-hearth with a fairly thick fused-in magnesite surface above it. Many prefer only a few inches of fused material over the rammed bottom.

The general construction of a basic open hearth bottom is well established, and there has been little change in recent years in the shape of the pan or the steel work supporting it. There is no great difference of opinion regarding the brick sub-hearth laid on the pan. Fully or partially rammed bottoms have become almost universally accepted. Few of the furnaces built in the past ten years have bottoms of all burned-in grain magnesite. There have been exhaustive studies, made at great expense by several steel producers, to determine relative merits of various ramming materials and to establish whether the fully rammed, partially rammed or fully burned-in bottom is best. Reports of their findings have been freely publicized, and all have had the opportunity to profit from the work done, but one must conclude that the perfect bottom is yet to be built.

The proceedings of the National Open Hearth Committee for 1945 give an analysis of a "Questionnaire on Open Hearth Bottom Construction and Materials,"[10]* by W. S. Debenham, ceramic engineer, Carnegie-Illinois Steel Corp. The response to the questionnaire came from 46 plants or shops, representing a total of 610 furnaces, and indicate a wide difference of opinion. In summarizing, Mr. Debenham stated:

* Numerals refer to Bibliography at end of article.

1. "Rammed bottoms are generally accepted as satisfactory; for, despite the probability of lower steel production rates, a majority of plants will continue to ram bottoms.
2. "A well burned-in working surface of substantial thickness is still preferred by most operators. Since this implies some skepticism of the performance of a rammed working surface or of the subsurface condition, the desire to ram in such cases must be motivated primarily by the speed and relative ease of installation.
3. "While there are several indications of a trend toward higher MgO bottoms, there appears to be a greater concern for the physical nature of the hearth, particularly in rammed bottoms.
4. "Inverted basic-brick arch bottoms apparently have made a favorable impression in the few plants that have tried them.
5. "The position of the plastic chrome subhearth is less clearly indicated than that of rammed bottoms. There may be two reasons for this. First, its location well down in the bottom, primarily for the purpose of protection, does not normally permit a ready evaluation of its merits. Second, chrome subhearths and rammed bottoms are generally considered incompatible, owing to the preference for burning in the chrome, hence those chiefly interested in fast and easy installations might find in favor of ramming despite satisfactory past experience with chrome subhearths.
6. "The open hearth operator has forthrightly accepted the chief responsibility for future improvements in bottom life. However, by so doing he feels that he has the right to expect, and has so indicated that the refractory manufacturers should as willingly recognize and accept their share of responsibility for improving performance. Certainly the data presented here indicate no reluctance for experimentation or any lack of opportunity for improvement."

The author recalls a first helper some twenty-five years ago who often said, in those days of producer gas fuel, that his idea of heaven would be "lots of gas and bricks that won't burn." I would like to add "a bottom that never has a hole in it." Repairing a hole in the bottom after tapping with a minimum of time and effort involves two things, getting the hole dry as fast as possible; then filling the hole and properly setting the material used. Where in former years draining was a long drawn-out process, it can now be done much quicker and easier with the intelligent use of oxygen. Many operators are using this method, which seemed to follow the use of oxygen for lance work in carbon reduction. Use of quick-setting, high magnesium oxide bottom materials to fill the hole will then get the furnace back in production with a minimum of lost time.

Most open hearth operators have seen, at sometime or other, one or more furnaces in a shop that were consistently high in tonnage produced, and low in lost time for bottom and bank delays. The crew of first helpers who manned the furnace would have the reputation of taking good care of their bottom. They never seemed to be in trouble with bank and bottom boils, while other furnaces using the same materials for repairs and making the same grade of steel, seemingly could not get a heat ready without some trouble. I believe one of the secrets is that some men make a study of their metal temperature, and never get the heat hot until ready to tap. They seem to live on the top 2 in. of their bottom, and by dressing up after each tap always have a good solid bottom to work on.

The purpose of our constant struggle to build a dense, strong and chemically resistant hearth or bottom, is three-fold:

1. To make sure we have a sound bottom or hearth in which to work the heat, so that we make the specification scheduled, and are not forced to tap prematurely before the heat is ready, because of bottom or bank boils.
2. To minimize delays between tap and charge, so that we have more furnace hours in production, and added tonnage as a result.
3. To spend fewer dollars for refractory materials, fuel and labor repairing and maintaining our bottoms.

Reviewing the many papers that have been published in recent years, and the discussions that take place at meetings, too little is said about the training and education of the personnel on whom we must depend to accomplish our objectives. Most of the actual work of this program is in the hands of our first helpers and melters. Regardless of time and money spent on our eternal quest for better materials, we fail unless we acquaint these people with our objectives, and make an honest attempt to teach them how to use these materials properly. Most all open hearths today have the same common problem in regard to promotion by seniority, of men, to the first helpers position, so that we must depend more than ever on the melter foremen to select, train, and supervise all phases of the furnace cycle, charging, melting, working and tapping of the heat and then see that the bottom is properly prepared for the next charge.

Gone are the days when the melter could call it a day when he tapped the heat. I often recall a story told me years ago by a melter, regarding an incident that happened when he was first-helping on the 14-hour night shift. The first helper sent his second helper to waken the melter when his heat was ready. The melter came down the floor, picked up a rod and balanced it in the wicket hole in preparation to "burning it off" for a temperature test. He pulled his glasses down on his nose, looked in the furnace, pulled the rod back out, walked over to the first helper and said in disgust, "thought you were ready," then went back to his office and to bed. The first helper discovered he had an empty furnace—the heat was in the cellar. A lot of progress has been made since this happened, and today the melter must be constantly aware of what is going on in all of the furnaces he supervises, and must check and double-check his bottoms.

At our plant, some two years ago, we started a first helpers "school," and "classes" were held in the evening from 7:30 to 9:30 P.M. During the four months this program was in effect, we solicited help from various suppliers, and had some interesting sessions with the brick and hearth refractory representatives. Many of

our men were told the story of proper use of various materials for the first time, and we believe it has paid dividends to the company in helping reduce bottom delays, but here again we are dependent on the melter to follow through on our program in actual application on the job.

About a year ago, in an article "Production of Open Hearth Steel,"[2] by a man who has long been prominent in our business, it was stated: "Workers in steel plants, three to four decades ago, had dirty, hard, hot, man-killing jobs. Furnaces were inefficient, campaigns were short, brickwork did not last long, fuel consumption was high, tons per hour low, delays were excessive and quality control practically unknown."

"Engineers, metallurgists, chemists and operators, by careful, painstaking and often disappointing study of the process, its limitations and possibilities, slowly began to make improvements in construction, in quality and type of refractories used." He also stated, "Happy is management when it has a crew of well-trained, interested men." I agree wholeheartedly with this author. Today much of the hot, dirty, hard, man-killing work has been eliminated, but our training program has not kept abreast of the technical advances available, and we should be making an effort to catch up.

It is my firm conviction that the open hearth furnace operators job (the first helper) should be an apprenticeable trade, and negotiated with the union as such. While apprenticing the "first helper" trade would offer us no immediate solution to our problem, it would guarantee us, however, a steady flow of well-trained manpower two or three years from now, and build a solid foundation for our organizations of the future. Merely as a tentative plan, the following training schedule has been outlined, showing the work assignments of the apprentice first helper, and the corresponding classroom work. Also shown is an arbitrary time to be spent on each of the work or classroom assignments.

Work assignment	Class room assignment
First assignment	1. Various refractory brick and its uses.
1. Bricklayer helper, (open hearth only) a. Six month period (40 hr a week)	2. Open hearth furnace construction. a. Six months period (2 hr a week).
Second assignment	**Class room assignment**
1. Fuel dept. a. Six month period (40 hr a week).	1. Open hearth furnace instruments—their use and adjustment. 2. Open hearth fuel, combustion, draft control etc., and their efficient use. a. Six months period (2 hr a week).
Third assignment	**Class room assignment**
1. Third helper a. 12 months (40 hr a week). 2. Second helper b. 12 months (40 hr a week).	1. Bottom and bank maintenance. 2. Explanation of chemistry and metallurgy of open hearth process 3. Make-up of runners, joints and use of auxiliary equipment. 4. Alloys — their use and effect. a. Two year period (2 hr a week).

If such a program were adopted and could be negotiated:

1. All present first helpers could enroll and attend if they so desired.
2. Our present second and third helpers could be granted partial credit covering that portion of the work assignment they have already completed. All present second and third helpers would have to enroll in the course if they desired to advance; if they did not enroll, they would retain their present classification, but be denied the right of promotion.
3. All future first, second and third helpers to be enrolled in or have satisfactorily completed the course.
4. All personnel desirous of enrolling in the course would be required to pass a preliminary classroom examination. Periodic classroom and work assignments would establish merit ratings. A predetermined standard would have to be maintained to compensate management for the investment, and to permit the employee to continue the prescribed course.

In briefly summarizing, a good percentage of our bottom and bank trouble is created by the human element. While there is room for improvement in the chemical composition and physical characteristics of basic open hearth banks and bottom construction and repair refractories, we have not gained all of the possible efficiency from the present ones. We must take the necessary steps to assure us of a steady flow of well-trained personnel to operate and maintain our furnaces. We must accept the responsibility of properly training these people to do a job for us.

If all of our first helpers today had on-the-job and class room training as concerns furnace construction, refractory materials (their composition and use), the chemistry and metallurgy of steel making, fuel (combustion, controls, etc.), and alloying elements, we could be assured by all reasonable means that we had qualified men to run our furnaces. We would be bringing our people abreast of the industry, we would be making an apprenticeable trade of first-helping and guaranteeing they had been at least exposed to the necessary knowledge and know-how. Steelmaking is an art in every sense of the word, and we should stop treating the training of personnel in such a hit or miss fashion. First helpers who had served their apprenticeship and were graduated journeymen could once again travel from shop to shop, as of old, adding to their experience and knowledge.

It would minimize, if not eliminate, many of the present day problems existing in our industry with labor. It would provide a sound basis for training and evaluating our personnel. It would accomplish more tons per hour, less fuel per ton and greatly decrease bottom and bank trouble.

SUMMARY

Work assignment	Class room assignment
Three years or 6000 hours	3 years or 300 hours.

Requirements: Age — 20 to 30 years.
Education: High school or passing an equivalent test.

BIBLIOGRAPHY

1. *"Analysis of Questionnaire on Open Hearth Construction and Materials,"* W. S. Debenham, 1945, A.I.M.E. Open Hearth Proceedings.

2. *"Production of Open Hearth Steel,"* L. F. Reinartz, Steel, January 17, 1949.

TRENDS IN ELECTRIC ARC FURNACE PRACTICE

By DONALD L. CLARK
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. . . . the trend in electric furnace practice is such that it might soon give the open hearth competition in the production of ordinary grades of steel . . . . it is, of course, the outstanding unit for quality steels . . . .

▲ THE standard tonnage electric melting tool is the three-phase direct-arc furnace. It is now manufactured by four companies in the United States, one in Canada and five in Europe.

For several years after its debut in the United States, there was considerable competition by other electric arc designs; these, however, eventually lost out to the three-phase series-arc furnace as developed by Heroult. It is this design which is our main interest, and its history and trends in development, as well as economics, follow.

HISTORY

Heroult's early direct-arc furnaces, first patented in 1886 and developed for the smelting of aluminum, carbide and ferro-alloys, were first used for the production of steel at LaPraz, France in 1900, just 50 years ago.

In this country, on April 5, 1906, Dick Read at the Halcomb Steel Co. plant in Syracuse, N. Y., cast the first heat of electric steel. This heat was made in a four-ton, single-phase, two electrode Heroult furnace resembling in shape the rectangular gas-fired Wellman open hearth furnace from which it was to receive hot metal for deoxidation and refining. Three other cold-melt heats were melted before making the first duplex heat on April 10, 1906.

The first round shell Heroult was installed at the South Chicago plant of the Illinois Steel Co. in 1908. It was also the first three-phase Heroult steel melting furnace.

As the advantages of electric arc melting became apparent and the quality of its product was proven in the field, the number of installations steadily increased. By January 1, 1948, the number of direct-arc furnaces operating in the United States was 787.

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DOOR CHARGING

The early electric arc furnaces were small and hand charged; as the furnaces became larger, and increased production was desired, improved methods were developed. Advance was made from chute-charging through machine-charging to top-charging. Nevertheless, it took a good number of years for this development to reach its present well defined position.

The earliest use of chute-charge was possibly by National Malleable Steel Castings Co. in Sharon and Chicago about 1916 or 1917. They charged through a 2-ft hole cut in the furnace roof. By 1918 Moore was promoting chute-charging through the doors of his furnaces. His placing of the transformer, connections

Figure 1 — A 3-ton, 3 phase Snyder furnace. This is one of the first top charge furnaces ever built, and was known as the "coffee-pot" type.

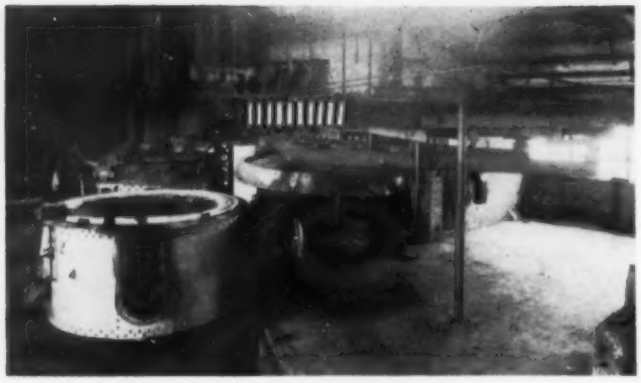


Figure 2 — An early top-charge "multiple" furnace manufactured by Swindell-Dressler Corp.

and masts at the side of the furnace instead of the back allowed easy chute-charging while the furnace was in a tilted position.

Also in 1918, South Works, Illinois Steel Co., Chicago, used machine-charging which was probably the first on the electric arc furnace. With the growth in size and appetite of the electric furnaces, adoption of the open hearth machine-charging methods became universal. The growth in size is shown by the furnace capacity in tons and its year of introduction.

25-ton	South Works, Illinois Steel Co.	1916
40-ton	Charleston Navy Yard (Shallow Bath — 18 ft shell — 50-ton hot metal)	1918
40-ton	Timken (Regular bath — 16 ft 6 in. shell)	1925
100-ton	Timken (Elliptical shell, 6 electrodes)	1927
80-ton	Timken	1932
100-ton	Timken	1936

TOP CHARGING

In a discussion of trends, the trend from door-charging to top-charging has been most definite and extremely interesting. It started with the Snyder "coffee pot," brought to this country in 1911 and illustrated in Figure 1. Then, at the end of World War I, Ludlum Steel Co. brought out a type of furnace where the body ran out over the pit from under the superstructure. Adaptations of both of these were designed by Sam Arnold and used by other concerns.

Swindell introduced a German design of two furnaces mounted on a turntable in 1923. The top charge feature added in 1924 is illustrated in Figure 2. This "multiple" arrangement allowed power to be applied to the second furnace as soon as melting operations on the first furnace were complete. As can be realized, this design was very desirable in foundries with long tapping times.

The first swing-roof type of top charge, seemingly based on Priwer's 1921 patent, was installed in 1927 by Pittsburgh Lectromelt Corp. at Bethlehem Steel Co., Bethlehem, Pa. This type is shown in Figure 3 and Figure 4.

The gantry crane type shown in Figure 5 and Figure 6 had its first heat poured in this country on May 3, 1937 at Ludlum Steel Co., Dunkirk, N. Y. It was installed by the American Bridge Co. It should be noted that varied top charge designs appeared much earlier in Europe. Stein et Roubaix started their first gantry type in the spring of 1914. During World War I, both Siemens and Demag in Germany built gantry type top-charge furnaces. Today, Birlec in England, EFCO in England, Stein et Roubaix in France, Belgium and Italy, and General Electrica Espanola in Spain are building top-charge furnaces of the swing-roof type. Brown-Bovari in Switzerland has adhered to the gantry design. Returning to the United States and Canada, we find four companies manufacturing the swing-roof type and the fifth manufacturing both top charge designs.

As recently as 1941, articles in technical and trade

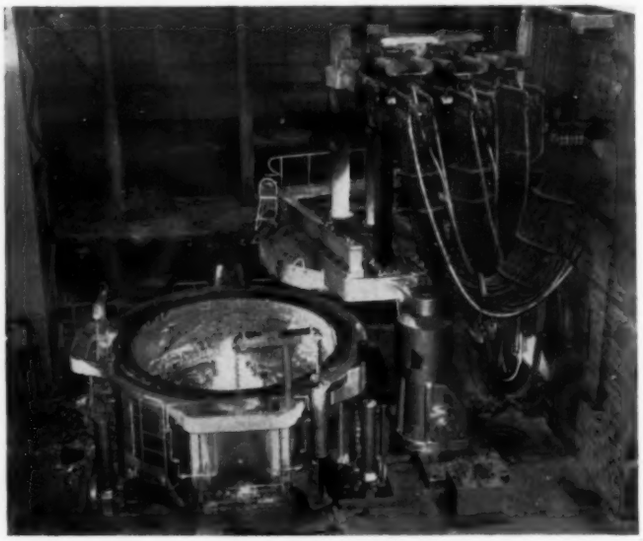


Figure 3 — A 17-ft diameter Lectromelt furnace with roof raised and rotated ready for charging.

journals appeared which stated that a definite limit existed as to the size of electric furnace to which top charging was applicable. Most of us can remember hearing that a 14-ft shell was the limit, and later that a 16-ft was the maximum. But recently 18-ft shell installations with swing-roof construction have been successful and, no doubt, we will soon see larger top-charge furnaces in production. It is evident at this time that the ultimate limit has not yet been determined.

The definite cost savings per ton of steel produced has brought about a ready acceptance of top charging for all size furnaces. For the record, Figure 7 shows a 500-lb swing-roof furnace which was designed and manufactured for a customer who insisted that a top charging design was economically justified for him even in this small size.

It might be mentioned that some large furnace operators find that a top-charge furnace with machine-charge facilities for working the heat gives the most rapid and most economical production.

HEIGHT OF SIDE PLATE

The original Heroult furnaces in this country had very low side plates. Over the years the trend was a gradual deepening of these plates. From 1935 to 1937 the trend became more apparent as the savings in refractory life made itself evident. However, the greatest change was during the war years when the scrap situation became so acute.

As an illustration of the above, the side plate of one manufacturer's 16-ft shell changed from 4 ft 3 in. in 1937 to 6 ft 4 in. by 1948. The concurrent change in cold scrap capacity was from 830 to 1140 cu ft. Many machine charge furnaces, when changed to top-charge, gained an additional 400–500 cu ft of cold scrap holding capacity.

A development along these lines to increase scrap capacity and improve sidewall life was the conical shell. The first installation was of two 15-ton furnaces at Rustless Iron & Steel Co., Baltimore, Md. in 1936. The next was a 25-ton installation at Rotary Electric Steel Co., Detroit, Mich. in 1937 and then two 50-ton units at Crucible Steel Co., Midland, Pa. plant in 1939. (See Figure 8 and Figure 9.) No newer installations of this type are on record.

Interesting to note is that European side plates have always been deeper. It also appears that, in this country, the side plates have not as yet reached their maximum height.

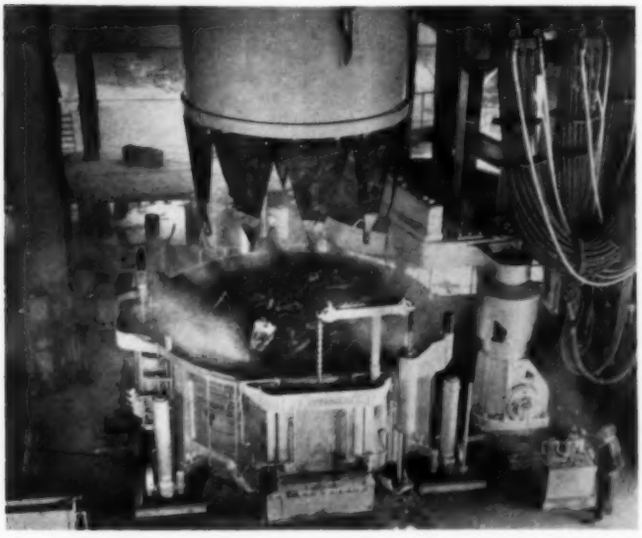


Figure 4 — This is the same furnace as in Figure 3, just after the charge has been placed by drop bucket.

WELDING

There has been a change from riveted to welded construction. Also, there has been a more recent change from cast parts to weldments. This trend has been brought about by high pattern costs and production of so many models. As for the welded shell, which has been in use for some time, it appears that those for the large furnaces may possibly be made in two or three sections and bolted together to improve expansion and contraction characteristics.

ELECTRODES

The first Heroult furnace installed in this country at Syracuse used a carbon electrode approximately 15 in. × 15 in. × 80 in. that was imported from Sweden. Up until this time, in the United States as well as in Europe, the manufacture of electrodes had followed the development of the aluminum industry. Electrodes larger than 12 in. in diameter were not obtainable in 1907 so Heroult, in 1908, built a plant at Welland, Ontario, and made carbon electrodes up to 20 in. square. In 1910 he started the Electrode Co. of America in Niagara Falls, N. Y., and installed equipment to make electrodes up to 24 in. in diameter.

Following is a history of the large carbon electrode sizes and the year of their appearance.

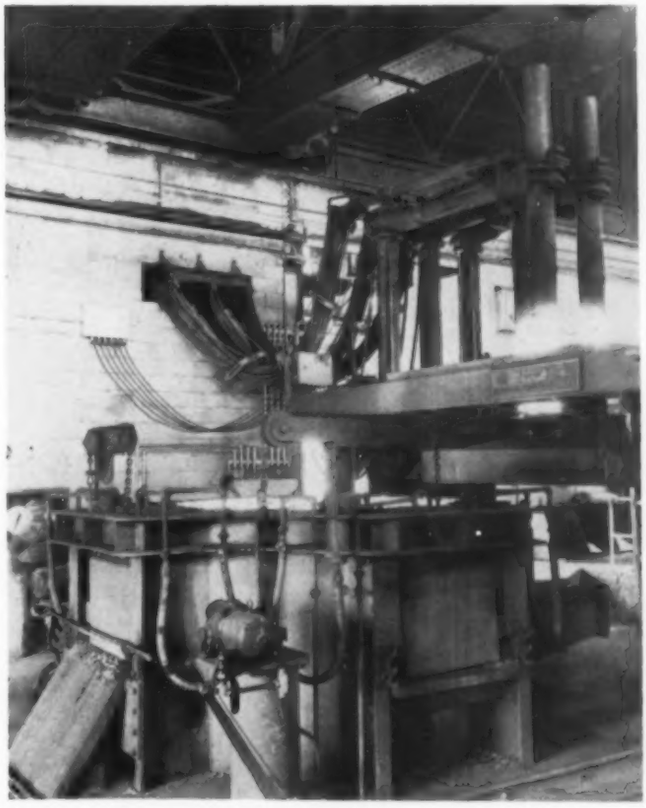
Diameter	Year
12 in.	1907
24 in.	1910
30 in.	1926
35 in.	1927
40 in.	1929

Sizes larger than 24 in. are given only as a matter of interest. They are not used in steel producing furnaces but are used only on carbide and ferro-alloy electric arc furnaces.

Where higher current carrying capacities were required, and the superstructure on the arc furnaces could no longer be practically made to withstand larger and heavier carbon electrodes, industry changed to graphite. Following is a similar history of the larger graphite electrode sizes.

Diameter	Year
12 in.	1914
14 in.	1918
16 in.	1924
18 in.	1928
20 in.	1937
24 in.	1944
30 in.	1944

Figure 5 — A 9-ft shell Heroult furnace of American Bridge Co. design showing gantry roof in position for charging.



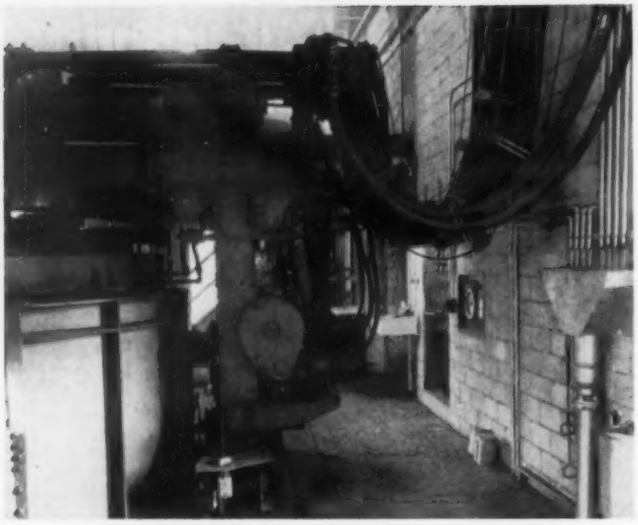


Figure 6 — This Heroult furnace shows gantry construction on mast side of top charge furnace.

Sizes larger than 20 in. have been used only experimentally and just on carbide and ferro-alloy furnaces.

Furnaces with graphite electrodes produce by far the largest tonnage of electric steel.

Practically all of the new furnace installations, even in the smaller sizes, now use graphite electrodes. When and if the electric furnace designers want larger electrodes, the electrode industry is already prepared for them.

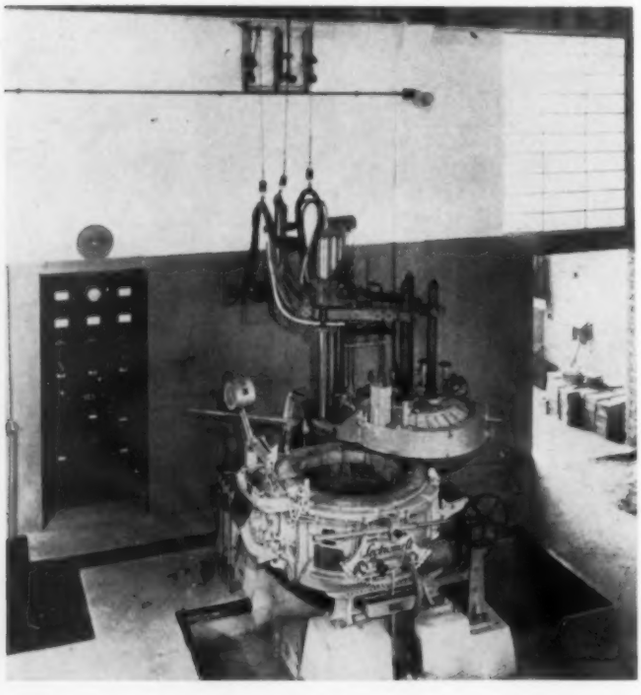
ELECTRODE HOLDERS

Early electrode clamps were of the multi-section bolt type. About 1929, the wedge-type clamp came into the picture. This type may be easier on the holder from the standpoint of constant flexing, but it certainly had its headaches, as the operating men well know.

Next came the shoe clamp of Booth's, which was held against the electrode by a threaded rod working through the center of the electrode arm with pressure being applied by means of a hand wheel at the back of the crosshead. This same principle, with the shoe held by a wedge, is also used, and it is a great improvement over the original wedge type.

Then about 1937, the pneumatic-operated clamp was first built in this country and today is practically standard equipment except for the hand operated shoe type on smaller furnaces. Two pneumatic types are used; in one, the shoe is held by very strong springs and released pneumatically; in the other, the shoe is held pneumatically and released by springs concurrent with the decrease of air pressure. An "old timer" would probably say, "What next? An easy chair and remote control by television, I suppose." However, the safety considerations as well as the economics of not having a man spend time on the roof with a frozen screw or wedge, will justify the use of such improved equipment.

Figure 7 — A 500-lb capacity top charge furnace. This is the smallest swing-roof top charge furnace built by any manufacturer.



ELECTRODE REGULATORS

Although Siemens in 1878 used an automatic regulating device on his vertical-arc furnace, and some furnaces employed automatic regulators only after meltdown, the earliest commercial available automatic regulator was the Thury unit, a European development invented in 1898. This was installed with the first Heroult at Syracuse. In 1915, the General Electric Co. brought out the Seede regulator which operated on current only, and because of ease of maintenance, dominated the field for years.

Westinghouse, in the early 1920's developed their balanced-arm unit, characterized by both current and voltage control. This type of control, or a modified Seede unit, was used universally until the early 1940's.

In about 1940, a modification and improvement of a European system by Allis-Chalmers was offered in the rotary, or variable voltage regulator. These regulators, now produced by three companies, operate under control of both electrode current and arc voltage. Their advantage lies in the fact that the electrode speed is variable and is automatically proportioned to the degree of unbalance, thus resulting in a steady downward drive of the electrodes through the scrap. There has been a gradual trend away from the contact type to the rotating type control, although the older type is still available. As a matter of interest, it should be mentioned that the first European use of the rotating control was as early as 1915.

The latest innovation in regulation was the introduction of an electronic regulator in 1944 by Westinghouse. It is claimed that this provides all the features of the rotating regulator with the advantage of a complete absence of moving parts. Several installations of this regulator have been made, and, although favorable reports are maintaining interest, it is considered as still in the development stage.

CIRCUIT BREAKERS

There appears to be a recent and slow change from oil breakers to air breakers. The oil switches were never designed for the high frequency of circuit interruption on electric arc furnaces and now, with the development of the lower voltage air breaker, the trend seems to be more definite. Recommended are two circuit breakers; one for the highly repetitive duty resulting from switching at no-load and over-load, and the other for the infrequent but nonetheless severe duty of interrupting primary circuit faults. It should be noted, however, that on smaller installations, where the cost of two switches may seem prohibitive, expert advice is desirable in making the proper choice and decision.

VOLTAGES AND TAP CHANGERS

Before 1916 most furnaces were built with single voltages, or with taps above or below a base of 110. The star-delta or delta-wye switch feature, which supplies a dual range of voltages for melt-down and refining, was patented by Gray in 1916, and incorporated on steel melting furnaces as early as 1917. Tap changers were first used on steel melting furnaces in 1919, and the first high tension tap changer was installed in 1923. In 1926, Arnold patented a multiple voltage tap changer with balanced reactance. Motor-operated tap changers were used on carborundum furnaces as early as 1910, but were not adopted for steel furnaces until 1928. These and other innovations were added from year to year and readily became standard equipment.

The number of positions of the tap changer was gradually increased. Today most transformers are built with either 6 or 7 delta taps and 6 or 7 star taps, however, only 4 or 5 are customarily brought to the board. As far as is known, the maximum number of taps brought to the board of a steel melting furnace is 12, and that is at Ford Motor Co., Detroit, Mich.

The top voltage trend is shown as follows:

Year	Top voltage
1917	200
1924	250
1927	265
1931	295
1939	300
1948	450

Again, it is interesting to note that voltages of 300–400 were used in France as early as 1939.

TRANSFORMER CAPACITY

The trend on transformer capacity has been similar, with the ever present requirement of increased tonnage per hour and per man-hour, the demand for faster melt downs has resulted in the higher voltages and accompanying higher transformer capacities. The trend of the latter is illustrated by the following changes: in 1915 a three-ton or a ten-ton installation included a 750-kva transformer whereas in 1929, a three-ton installation was coupled with up to a 3125-kva transformer and the ten-ton with a unit up to a 5000–7500-kva capacity.

Figure 8 — Photograph of a "cone" furnace melting up to 50 tons.

There has been no change since that time on furnaces of these sizes.

On larger furnaces, transformer capacities have also increased; for example a 50-ton installation which in 1931 had a 10,000-kva transformer would today be powered by as high as a 16,000-kva unit. Seventy-ton furnaces are now backed up by as high as 20,000-kva units. The highest capacity transformer in electric melting furnaces today is a 25,000-kva unit. It must be remembered that with these increases the size of the heat tapped from any one furnace also increased but to a lesser degree.

Figure 9 — An unusual "composite" photo of tapping from the furnace shown in Figure 8.

REFRACTORIES

The types of refractories used in the construction of electric arc furnaces have changed very little, and the only trend is in the development and use of higher quality materials of the same type, with more attention being given to proper grain-sizing.

Nothing need be said on the acid linings, but some minor changes for the basic furnace can be mentioned. All basic bottoms were formerly made by sintering layers of magnesite grain, tar, or other binder, and ground basic slag, or other flux to the required depth over the courses of brick against the shell bottom. A few operators in 1930 found that finely ground grain magnesite with an air drying binder, if well rammed to the desired depth, heated slowly to the fusion temperature and held there for several hours, was not only very satisfactory but more easily and rapidly installed.

Commercial mixes duplicating the above were introduced in the mid-thirties. Once tried by electric furnace operators, very few basic furnace bottoms were installed by the older method. Drying and heating times have recently been essentially eliminated by some, though it must be understood that it would not be possible by those using duplexing operations.

In sidewalls, the use of hard burned magnesite brick and metal-encased bonded magnesite brick has, in most instances, replaced partially or wholly the use of silica brick.

In regard to furnace roof construction, the type of roof most suitable for each plant will vary according to circumstances; whether a series of special shapes or a set of standard shapes should be used is determined by the plant economics involved. In general, it has been found that more economical life is obtained in larger furnaces by the use of standard shapes.

Some good roof life has been reported by users of super-duty silica brick and super-duty fireclay brick. And, although under certain operating conditions, installation of the higher alumina or sillimanite-mullite refractories have been economically justified through extended roof life, silica brick generally shows the lowest cost per ton of steel produced. Until operating conditions become more severe, this description of refractories is representative.

EXHAUST SYSTEMS AND DUST CONTROL

The elimination of dust and fume has always been somewhat of a problem for shops with electric arc furnaces. With the advent of gaseous oxygen for carbon removal it has become a more serious problem.

A few, particularly casting shops, have turned to special exhaust systems on old as well as new furnace installations. One type of dust removal system is shown in Figure 10. Eventually we should see even the larger furnaces with exhaust systems.

MELTING CAPACITY

Turning now to melting capacity, we see in Figure 11 that by 1919 the electric furnace steel capacity for the country was already over 1,000,000 net tons. In 1934 the apparent decline in capacity is not correct. The American Iron and Steel Institute that year changed to reporting a figure which included only that portion of casting capacity held by companies producing steel ingots. From here on, however, things began to change rapidly, especially after 1940. Capacity in 1946 reached 5,500,290 net tons, then slipped back in 1947 to 5,076,240 net tons. After that, capacity again started on the upswing. At the beginning of this year the electric furnace capacity reached an all time high of 6,112,870 net tons. Advance reports expect it to be up to 7,000,000 tons by next year. Although the electric furnace capacity increased 225 per cent between 1940 and 1949 while the total steel capacity for the country increased only 18 per cent in the same period, no such dramatic change is to be again expected.

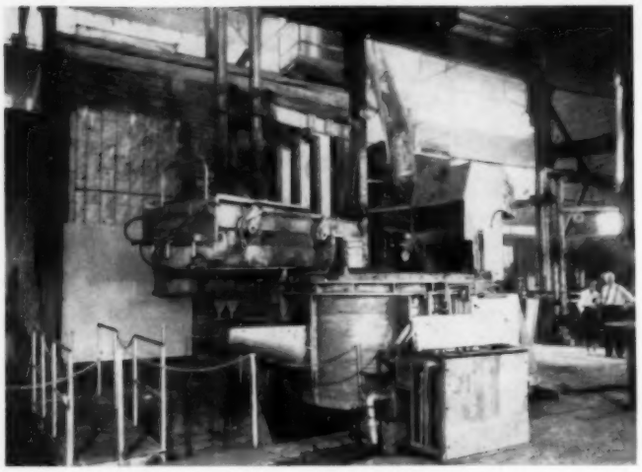
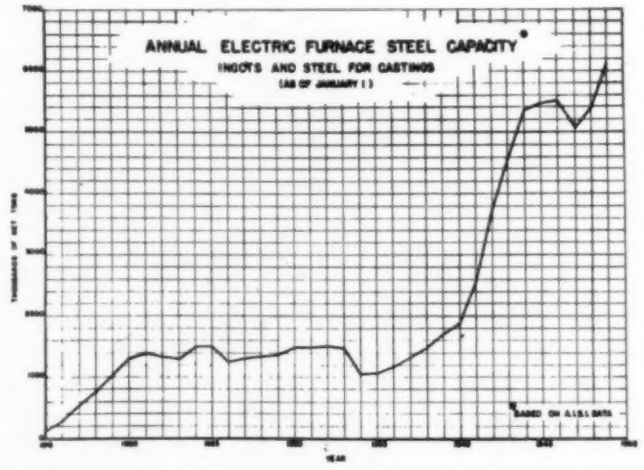


Figure 10 — An exhaust system of dust control on an electric furnace.

PRODUCTION

As to actual production, Figure 12 shows the electric furnace percentage of the total yearly steel production, i.e. of the open hearth, bessemer, crucible and electric

Figure 11 — The yearly electric furnace capacity up to 1950 is given by this chart.



furnaces. Starting from 1915 at just under 0.25 per cent, a gradual increase is noted up to 1940 where the electrics produced 2.54 per cent of the total steel tonnage. In the next three years it reached 5.17 per cent and finally reached a high in 1948 when the percentage of the total was 5.71 per cent.

In 1949, the seven month figure dropped to 4.78 per cent. This drop can be explained in several ways: First, the integrated plants with high cost electric furnace units naturally took them out of production; second, in these integrated plants it is much easier to shut down and restart electrics than it is with any of the other types of furnaces. As soon as our steel production schedules can be based on normal expectancy, we should again see each year a gradual increase in the percentage of steel made in the electric furnaces.

Turning to alloy and stainless steel production (Figure 13) we find that the electric furnace produced 9.3 per cent of the total as early as 1923. In 1944 the percentage had jumped to 34.1 per cent, an all time high. Since then, the percentage decreased (1944–1947) and then in 1948 started to show a gain which has continued in the first seven months of 1949. The decrease from 1944 through 1947 can be attributed to unusual economic factors prevalent during this period, the most important one being the huge backlog for basic steels. The electric furnaces were used to help reduce this demand and the use of open hearth single-slag practice more than ever became prevalent on such steels. The effect of this departure from standard electric furnace practice is included in the discussion of operations and costs which follows.

OPERATIONS AND COSTS

The ever-increasing tonnage per man-hour and consequent lower cost obtained in the electric arc furnace process has brought it more and more into competition with the open hearth. Responsible for this, in addition to top charging and to the utilization of higher secondary voltages during meltdown, is the use of single oxidizing-slag practice. Some of the actual rates are shown in Table I contrasted with two-slag practices.

TABLE I

Weight of heat	Single slag ton/hr	Two slag ton/hr
8 tons	3.5	2.0
12 tons	4.8	2.5
20 tons	8.0	3.1
30 tons	12.0	8.0
50 tons	14.5	11.0
70 tons	15.0	12.5

From these figures it is easy to see why one large basic electric furnace ingot shop reports that in the past two years it has changed from 100 per cent two-slag to 75 per cent single-slag, 25 per cent two-slag practice.

As for the costs on carbon steels, a recent month's figures from a basic ingot shop producing both cold-metal open hearth and single-slag electric furnace steel showed the electric production to be only $0.31 per ton higher. Consider also that this was with an exceedingly high power cost, possibly $1 or $2 per ton higher than normal, due to demand charges being carried by production at only 15 to 20 per cent of capacity.

In 1948 another basic ingot shop, with an excellent power contract, producing both carbon steels by the single-slag electric process (100 per cent scrap) and, carbon and alloy grades by the open hearth process

TABLE II

Scrap price, tons	Electric furnace cost per ton differential as compared to open hearth
$14.00	—$1.00
16.00	+ 0.00
18.00	+ 1.50
20.00	+ 2.50
22.00	+ 3.50
24.00	+ 5.00
26.00	+ 6.00
28.00	+ 7.00
30.00	+ 8.00

Figure 12 — Graph gives percentage of the total annual steel production made in electric furnaces.

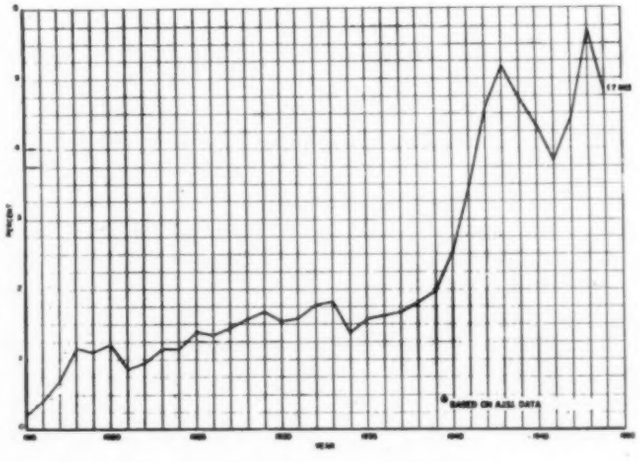
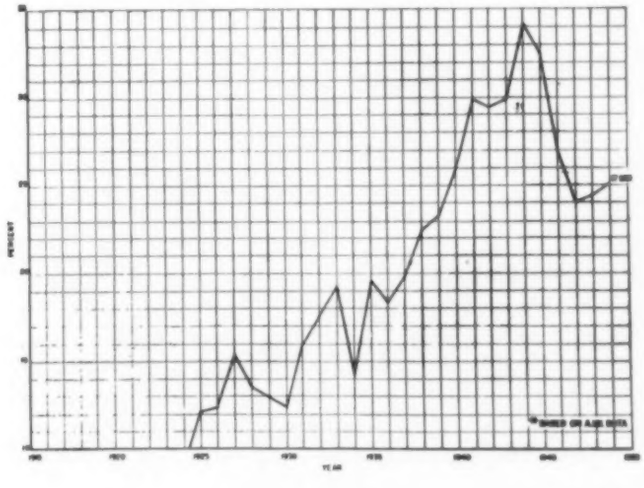


Figure 13 — The per cent of total annual alloy and stainless steel production made in electric furnaces is shown in this chart.



(45–62 per cent hot metal) shows the electric costs to be about $0.90 per ton higher. This shop, because of low scrap prices, predicted that its electric costs for 1949 would be as low or even lower than the open hearth.

The effect of scrap price on comparative costs of the two processes is shown in Table II by the figures from still another hot-metal open hearth and electric shop.

Comparing the major costs on a per tonnage basis, we find that, capitalization, building repair and maintenance, furnace repair and rebuilding, labor, fluxes and slag disposal are lower for the electric furnace, while, fuel (power), refractories, molds and general supplies are lower for the open hearth.

SUMMARY

The electric arc furnace has earned its prominence; by maintaining its early reputation for the manufacture of quality steels, because of its versatility in eliminating undesirable elements or conserving costly or strategic alloys, and, because of its flexibility of operation.

Its share of the total steel production will continue to increase, not only for the above reasons, but also because of lower operating costs which have resulted from improved furnace designs and practices aided by the most modern auxiliary equipment.

BIBLIOGRAPHY

"The Electric Furnace" — Stansfield, McGraw-Hill, 1914.

"Electric Furnaces for Making Iron and Steel" — Lyon and Keeney, Bureau of Mines, Bulletin No. 67, 1916.

"Electric Furnaces in the Iron and Steel Industry" — 1911, Rodenhauser and Schoenwa, Translation by C. H. Vom Baur, 1913.

"Modern Arc Furnace Design and Practice" — H. F. Walther, Proceedings of Association of Iron and Steel Engineers, 1941, p. 12.

"Refractories for the Electric Steel Furnace" — C. A. Brashares, paper presented to 45th AFA Convention, New York City, May 12, 1941.

"Melting Records of Crucible Steel Co. of America, Halcomb Division, Syracuse, N. Y."

"Melting Records of Simonds Saw and Steel Co., Lockport, N. Y."

"The Modern Arc Furnace" — T. J. Ess, Proceedings of Association of Iron and Steel Engineers, 1944, p. 83.

"Proceedings, Electric Furnace Steel Conference" — AIME 1943 1948.

"Fifty Years of Progress in Foundry" — A. W. Gregg, *American Foundryman*, May 1946.

American Bridge Co., 1947 Catalog of Electric Furnaces.

Pittsburgh Lectromelt Furnace Corp., Catalog No. 7.

Whiting Corp., Hydro-Arc Division, Bulletin FY-130.

Volta Manufacturing Co., Catalog AF-AFR43.

"Annual Statistical Report of the American Iron and Steel Institute" — All yearly issues.

DISCUSSION

PRESENTED BY

H. H. NORTHRUP, Superintendent Open Hearth, Republic Steel Corp., Buffalo, N. Y.

DONALD CLARK, Melting Superintendent, Simonds Saw & Steel Co., Lockport, N. Y.

***JAMES CLARK, Melting Superintendent, Vanadium Alloys Steel Co., Monaca, Pa.**

***Now Assistant Melting Superintendent, Pratt & Letchworth Co., Buffalo, N. Y.**

JAMES KING, JR., Sales Engineer, National Carbon Co., Niagara Falls, N. Y.

ERIC TAYLOR, Electrical Engineer, Atlas Steels, Ltd., Welland, Ontario, Canada.

H. H. Northrup: Mr. Clark, you mentioned four changes in electric furnace practice and design which have increased production. Which of these do you feel has had the greatest effect in the tonnage increase?

Donald Clark: I would say the increase in transformer capacity which results in very rapid meltdown.

H. H. Northrup: Assuming you are using a silica roof, what practice do you use in heating up a new roof to operating temperature?

Donald Clark: Our practice in putting a new roof in operation on a new furnace is as follows: the roof already dried over a coil of steam pipes is placed on the furnace, and together they are slowly heated to operating temperature. We still use a 16 to 20-hr period.

The practice of initiating a new roof on a furnace already in operation is as follows: the furnace is completely charged, the old roof is removed, the new one put into place, the power turned on and the charge melted down in 1¾ to 2 hrs. This is the only heatup periods other than that of predrying over the steam coils which is mainly for drying the silica slurry.

H. H. Northrup: How many heats do you experience from the roof?

James Clark: I would say that the best practice would be to figure you have a definite roof life limit. The economics of trying to run it for several heats more is not worth having it fall in.

Donald Clark: That is what we do if it looks weak at 85 heats. We are not going to try to get that extra 15 out just to keep our records up, because we know if it falls in on us, we are going to lose more than we saved by leaving the old one on.

H. H. Northrup: How much hearth repair do you have between heats? Can you tie that down to an approximate figure in minutes per heat?

Donald Clark: The hearth repair between heats varies from 4 to 15 minutes. An average figure would be 10 minutes per heat. This is on a furnace melting 8 tons.

James King: There was an article in one of the steel magazines here a short while ago telling about practice in Sweden and Germany in which they use induction stirring. Is that something that has been used over here? Or is that something new out of the books?

James Clark: No, I do not think it is brand-new. It has been talked about, and I have read about it quite a number of years ago. As far as its actual use on large furnaces or production furnaces in this country, I do not know of any.

Eric Taylor: Do you know of any installations where transformers have been paralleled on the same furnace, in other words an installation where they had insufficient transformer capacity and rather than buy new transformers of greater capacity, they had two transformers of similar capacity which were used on one furnace.

James Clark: Yes, that is done.

Operation of New 16-In. ELECTRIC-WELD PIPE MILL

By C. W. MOREHEAD
Assistant General Works Manager
Page-Hersey Tubes Limited
Welland, Canada

. . . . the electric-weld tube mill described is particularly suited for Canadian market requirements . . . .

▲ THE manufacture of tubular products by means of electric resistance welding has been in use for thirty years or more for the manufacture of small sizes for mechanical purposes. Considerably less use of this method has been made for the manufacture of standard pipe. Approximately twenty years ago, Republic Steel Corp. in Youngstown, and the Youngstown Sheet and Tube Co., also in Youngstown, installed mills for the manufacture of standard and extra heavy pipe. Except for these mills, up until now very little pipe has been made by means of this process. No reference is here made to the process used by the A. O. Smith Corp. in Milwaukee, Wis., because of significant differences in the methods they are using compared with the type of mill at Page-Hersey.

For a good many years, Page-Hersey has been rather dissatisfied with its old facilities for making pipe larger than 3 in. These facilities consist of a lapweld mill which, although it has rendered service over a great many years, has now reached the point where the cost of production, due to high labor costs, make it impossible for this means of making pipe to remain competitive with more modern methods being currently used in the United States.

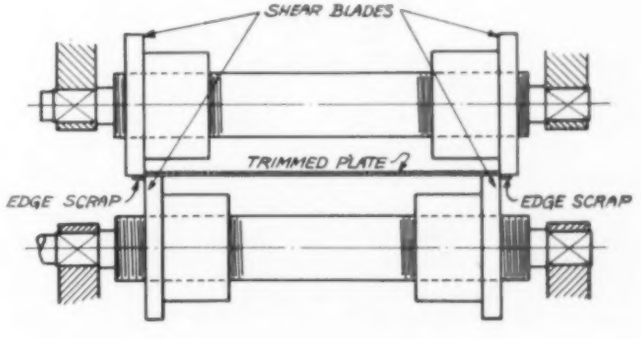
When the time came to choose the type of mill to put in, seamless, submerged arc welding, and electric resistance welding were considered. Because of the comparatively small tonnage requirements and diversification of sizes required by the economy of Canada, it was felt that the expenditure of the large sum of money necessary to install seamless equipment covering the necessary range of sizes of 4½ to 16 in. outside diameter would be unwarranted. Although submerged arc welding is well adapted for the production of large diameters, it is not satisfactory for the four to six-in. sizes which form a considerable percentage of our output.

This paper is not a dissertation on the theory of electric resistance welding of tubes, but rather a description of the new equipment recently installed at Page-Hersey. During the course of the paper certain points in connection with the theory and methods of resistance welding will be included, but most of these are used for illustrative purposes only.

The buildings used for the mill consist of a skelp unloading and storage area 65 ft wide x 400 ft long, of steel frame and corrugated sheet construction, and capable of storing approximately 25,000 tons of plate skelp. At right angles to this is the main building which is 110 ft 5 in. wide x 762 ft 8 in. long, and of steel frame, brick and steel sash construction. The skelp storage and the main building cover altogether an area of 110,100 sq ft.

To construct the machine foundations and floors in the mill, approximately 4000 cubic yards of concrete

Figure 1 — The edges of the plate are trimmed with circular shear blades.



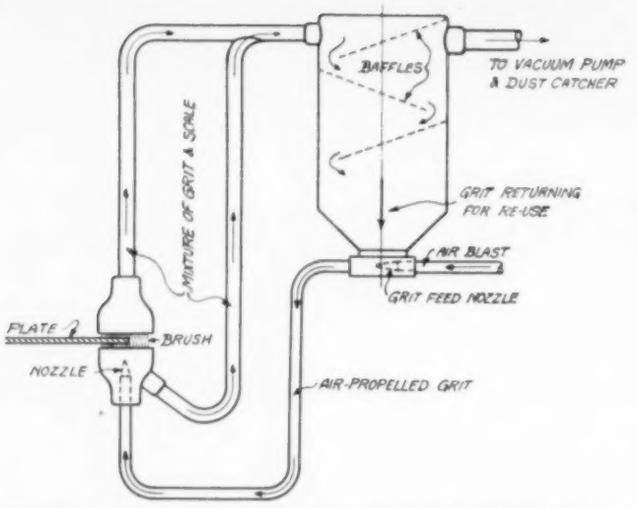
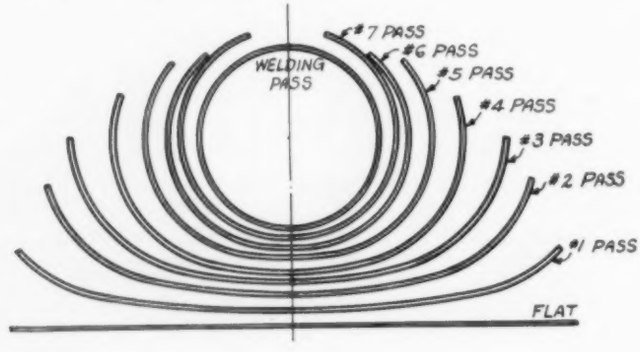


Figure 2 — Cleaning of the edges is an important factor in the successful operation of the welding process.

were required. To wire the mill, 8½ miles of steel conduit and 39 miles of wire and cable were used, and in order to run all the various pieces of equipment, there are a total of 287 electric motors, 194 of these being a-c and 93 being d-c, giving a total connected horsepower, including the welding unit, of 2550 hp.

At this time, the paper will follow one plate entirely through the mill to give an idea what the various operations are and their purposes. The plates are unloaded from railway cars either into the skelp storage area or placed immediately on the unpiler. The purpose of this machine, as the name indicates, is simply to remove one plate at a time from a stack and place it on the roller conveyor. Following this, the plate goes through a roller leveller in order to flatten it for succeeding operations. Immediately after the levelling is an end shear which was recently installed for the purpose of cutting off any of the crop ends which happened to be missed by the flying shear at the steel plant. The plate is then carried to the slitting machine which removes the surplus steel from the edges of the plates and gives a smooth and accurate edge for welding. After this comes the shot-blasting operation during which a narrow strip 3 in. in width is cleaned of scale by means of steel shot, in order to provide a clean area for the welding electrodes to make contact. The plate then goes to the continuous forming mill which shapes the plate into a cylindrical shape for welding. Immediately after the forming mill is the resistance welding mill which makes the weld, following which are bead trimmers for the purpose of removing the inside and outside welding flash. After this are two pull-out stands whose main functions are to keep a steady flow of the material through the welding unit. At this point, the pipe is transferred to the sizing and straightening mill whose functions are precisely what its name indicates. After sizing and straightening, pipe is given a preliminary inspection, to keep the mill crew constantly informed as to the quality of the pipe. After inspection, the inside of the pipe is washed by means of a high pressure spray to remove all traces of scale and dirt remaining from the welding operation. In order to remove the ragged ends left from the forming and welding operations and provide the necessary bevel for welding or threading, as the case may be, the pipe goes to lathe-type cut-off machines with automatic handling tables between them. The crop ends are then flattened in a hydraulic press located between the two pairs of cut-off machines. The purpose of this flattening operation is two-fold. First, A.P.I. specifications require the flattening of the crop end of each and every pipe as a test of the quality of the weld and, secondly, the pipe scrap is much more desirable to the steel companies after flattening. The pipe then proceeds to the testing and expanding machine, whose purpose is to increase the physical strength of the pipe and bring it up to size. After this, the pipe is given a final inspection, stenciled with the size, weight, test pressure, and other pertinent data, coated by means of a series of spray guns and loaded into cars for shipment. No threading is done in this mill at the present time, since in the existing lapweld finishing floor, there is modern threading equipment and any pipe requiring threading are transferred to this department.

Figure 3 — The shape of the section after consecutive passes is given in this sketch.



Handling of plates in the storage yard is by means of a 20-ton overhead travelling crane, but most of the plate and pipe handling is by means of individually driven roller conveyors, and transfer skids across which the pipe roll by gravity. For loading, and handling pipe requiring repairs, a 10-ton, two-hook overhead travelling crane is used and for roll changes and general repair work an old 35-ton crane is used.

Crop ends are handled from the cut-off machines to the flattening press by means of pallet conveyors. After flattening, crop and scrap is carried out of the building by means of an inclined conveyor.

Since the functions and operations of some of the equipment are obvious from their descriptions further description of only those parts of the mill which are the most interesting will be given. The operation which actually begins the manufacture of electric weld pipe is that of slitting. In order to make a satisfactory piece of pipe, it is essential that the edges be sheared cleanly and that an accurate width is maintained.

Figure 1 shows the principle of operation of this piece of equipment. Hardened circular steel knives above and below the plate on both sides separate the side scrap from the main body of the plate. The quality of the slit edge is controlled by the vertical and side clearances between knives. The shear is of the threaded through arbour type and the width is adjusted by

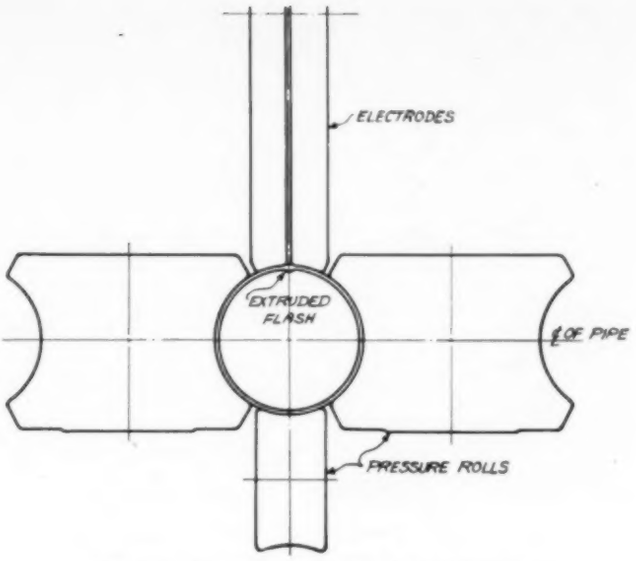
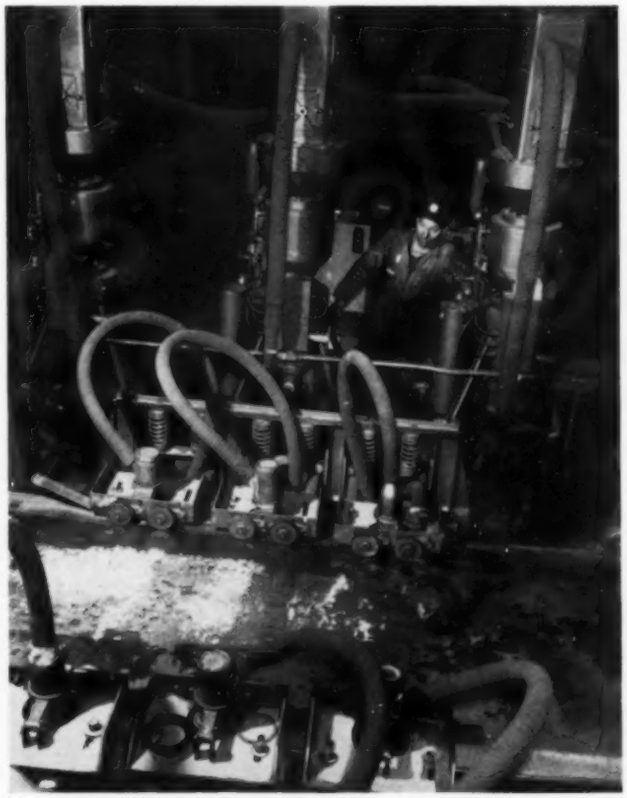


Figure 4 — Diagram of welding throat.

means of moving the cutters in or out, as the case may be, on these arbours. To obtain a good edge, a minimum allowance for side scrap of 1½ times the plate thickness is made on each edge. After shearing, this scrap is conveyed by means of guides to a lawn-mower type scrap chopper which cuts the scrap up into convenient lengths for handling.

The second operation in the actual manufacture of pipe is edge cleaning. Since the welding process is an electrical one and tremendous currents must be carried through a comparatively small area, this is a very important operation. Essentially, this machine (Figure 2) consists of an air blast which blows a stream of air at 100 psi pressure through a nozzle, in front of which a stream of grit falls, which is picked up by the blast and carried through a rubber hose to a nozzle immediately under the edges of the plates. The air propelled grit knocks the scale loose from a narrow path along the edge of the plate, and the resulting mixture of grit and powdered scale is picked up by means of a vacuum system and returned to a separating chamber consisting of a series of baffles over which falls the mixture of steel shot and powdered scale. The powdered scale, being light, is picked up by means of the vacuum system and conveyed to a dust catcher, while the grit drops down into a storage chamber where it is fed into the air blast to make another cleaning cycle. Three of these blast systems are required to clean each edge of the plate, and they are set so that the pattern from each nozzle overlaps slightly the pattern from the preceding nozzle. The frame work supporting nozzles is spring mounted and every effort is made to maintain the overall blast pattern uniform, and the proper width of 3 in. for electrode contact.

Figure 5 — The three nozzles of the shot-blasting machine overlap each other slightly.



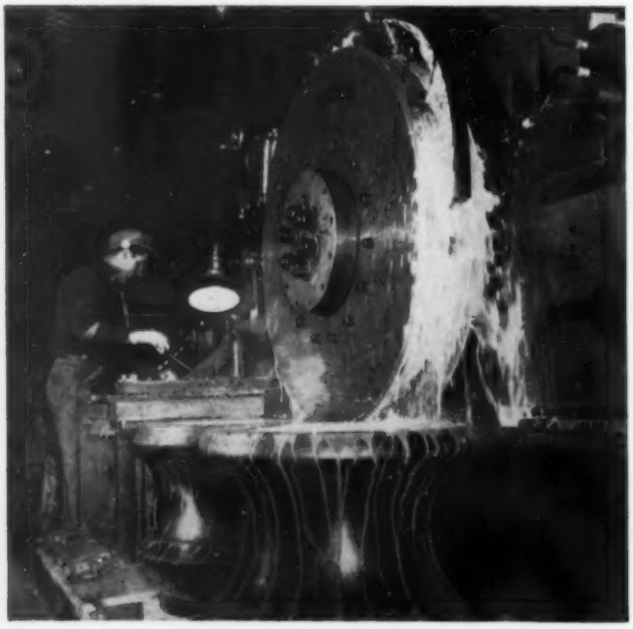
The forming mill consists of a series of individually driven rolls, each of which forms the plate a little bit more than the one immediately preceding it until an approximately cylindrical shape is reached. Figure 3 is designed to give a better idea of the forming process and shows sections taken through the partially formed plate at the center line of each pass. For the sake of clarity, the last two passes ahead of the welding unit have been left out rather than to clutter up the figure with so many lines as to make it illegible. The first four passes are breakdown passes and form the plate a little bit more than 180 degrees or, in other words, slightly beyond a "U" shape. Following this are idler passes whose purpose is to form the pipe sufficiently to enter the two fin passes. These passes deserve special attention, since they have a very important bearing on the quality of the weld. They have a disc projecting from the center of the top roll into the pass. The purpose of this disc is to work or burnish the skelp edges in order to remove any irregularities left from the side shearing operation. A second function which these fin passes have is to give the pipe the proper shape for matching the contour of the welding electrodes. Except for the idler stands which are on vertical spindles, all the rolls in the forming mill are individually driven by means of 20-25 hp, d-c motors. After the pipe leaves the last forming pass, it enters the welding throat which consists of the electrodes on the top, side welding rolls on the two sides and a bottom welding roll on the bottom of the pipe.

Figure 4 shows the welding pass. The two halves of the electrode which are made of a hard copper and insulated from each other are circular in shape and revolve with the pipe. The welding current which is in the neighborhood of 125,000 amp flows through one side of the electrode, through the contact surface between the electrode and the pipe, into the pipe wall and from there across the butting edges of the seam into the other side of the pipe and out again through the adjacent electrode. The 125,000 amp are a lot of current, and it is obvious after seeing the amount of

this current why it is necessary to clean the edges of the skelp for a suitable electrode contact. As the welding current flows across the seam from one side of the pipe to the other, it meets with a very high resistance at the point of contact and intense local heat is generated at the seam. At the same time, the pipe is maintained under pressure by the electrodes on the top and the welding rolls on the two sides and bottom. This pressure is sufficiently high to forge or upset the weld, giving a bead or flash on the inside and outside of the pipe. Both the inside and outside flash are then removed while still hot by means of tungsten carbide tipped tools to give a smooth finish inside and outside. The welding rolls, electrodes, and pull-out rolls, as in the case of the forming mill, are driven by means of individual d-c motors.

At this point, it may be well to digress somewhat and describe the electrical features of the forming mill, welding unit, and the sizing and straightening mill. As was mentioned previously, the various roll stands in the forming and welding mill, and sizing and straightening mill are individually driven by d-c motors. Since one of the most important variables to be controlled in this method of making pipe, is that of speed, a separate d-c generator was installed for the specific purpose of driving the various units of the forming and welding mill. By doing this, all variations in speed due to effect on the d-c voltage by other units in the plant are eliminated. The speed adjustment of these motors is by means of a motor operated shunt field rheostat to control the speed of the whole group of motors, with vernier rheostats for the adjustment of any individual motor relative to the others. To supply the welding current, a separate welding motor-generator set was installed to provide balanced 3-phase loading on our 25-cycle shop system and to avoid any effect on the weld from voltage variations from the hydro system. All the motor generator sets and incoming switch gear are in a separate air-conditioned room, and the power cables and bus bar are carried through an underground

Figure 6 — Pipe is shown going through welding unit.



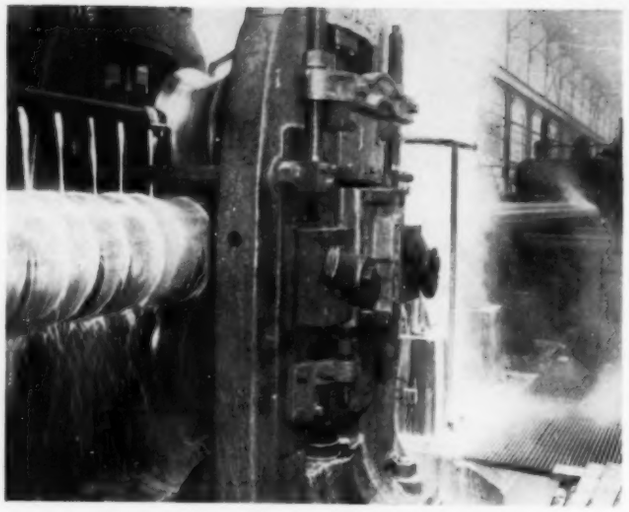


Figure 7 — The first stand of rolls in the sizing mill is shown in the foreground. In the background can be seen the welding unit.

tunnel to the 16-in. mill proper. The welding transformer is rated at 1667 kva 0.80 per cent power factor, single phase, 62½ cycle, 480 volts, on the primary side, and full load secondary current is 150,000 amp. A novel feature of the welding transformer is the fact that the entire transformer rotates so that only the primary current of 3500 amp, rather than the secondary current of 150,000 amp, must be transmitted through sliding contacts. The welding transformer secondaries are cooled by means of water flowing internally as are the conductors leading from the transformer to the electrodes. The electrodes themselves are cooled by means of an external water spray. Turning the welding current on and off can be done either by hand or automatically, but automatic control is preferred since hand control requires the constant attention of the operator at the control station and does not give him sufficient opportunity to watch his mill properly. The automatic control consists of a limit switch to contact the pipe, a welding timer to take care of the time elapsing between the operation of this limit switch and the time the end of the pipe reaches the welding throat, and the necessary relays and contacts for turning on and off the welding current. To overcome the delay of voltage recovery of the welding generator when the welding current is turned on, a rotating voltage maintenance regulator is used. This system permits the welding generator "off load" voltage to rise to a higher level than normal, which is dropped to the normal operating value when the welding contactor closes. This regulator also serves to maintain the welding voltage constant.

The operation of mill inspection and cutting off ends are quite obvious, so will not be described. The testing and expanding machine, however, is a very interesting piece of equipment, since it combines three separate and distinct operations within the confines of one unit. These operations are end belling, expanding, and hydrostatic testing. The pipe to be expanded is stored on the loading rack ahead of the machine and is lifted by means of a mechanical selector from these loading skids into the machine itself. Jacks then come up to support the pipe and the loading arms are withdrawn. Heavy split cylindrical shells are closed around the pipe for

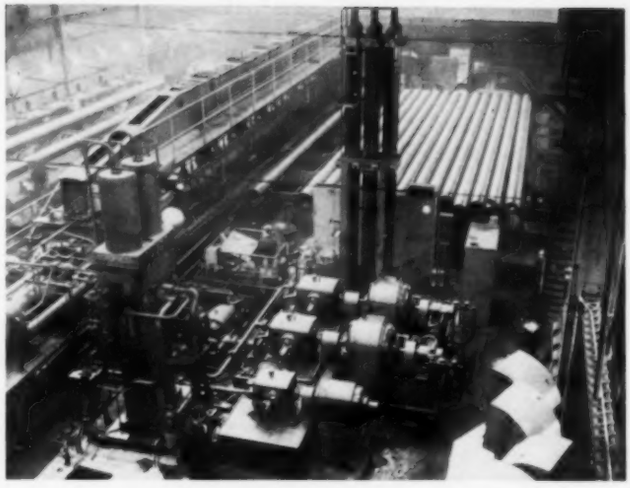


Figure 8 — The hydraulic expansion and testing machine is illustrated in the photograph. In the foreground are the hydraulic pumps, intensifier, high pressure accumulator and the operator's panel. The expanding machine is shown in the center.

Figure 9 — Two of the mantles are shown closed around the pipe and the remaining mantles of the expanding machine are in the withdrawn position.

the expanding operation and locked in place by means of air-operated clamps to ensure against their opening under expanding pressure. Belling tools are then forced into each end of the pipe to bring the pipe ends up to the final diameter. Immediately behind these belling tools are rubber gaskets connected to the expanding water supply by means of drilled passages through the heads. An electrically operated valve is then opened to allow the pipe to fill with water supplied by a 500 gpm pump which pumps into an air vessel loaded with 150 psi air pressure to maintain a steady and adequate flow during the filling period.

When all the air is exhausted from the pipe and the pipe is completely filled with water, the water inside of the pipe is brought up to the expanding pressure by means of a twin intensifier. This intensifier is oil hydraulic on the low pressure side and is connected to the water system on the inside of the pipe on the high pressure side.

In the case of the 16-in. outside diameter $\frac{5}{16}$ in. wall, the pressure required to expand the pipe is 2300 psi, but the machine is capable, if necessary, of developing pressures up to 5500 psi. As soon as the internal pressure exceeds the yield point of the material, the pipe expands until it reaches the inside of the cylindrical shells. The pressure then builds up another 150 to 200 psi to ensure that there are no flat or low spots in the pipe. This completes the expanding operation. The pressure is then released, and is then built up again to the test pressure with the enclosing shells opened so that the pipe can be inspected for any possible leaks. The pipe is then ejected from the machine and the machine is ready to expand another pipe. This operation gives a pipe of the proper outside diameter size and roundness, and in addition by means of cold work in the proper direction increases the transverse physical properties, particularly the yield strength. This is of great value for pipe to be used in welded pipe lines, since the high yield strength required for present day high operating pressures can be obtained, with low enough carbon and manganese content to permit easy welding in the field. In addition, it subjects the pipe to one of the most severe test short of actual destruction that has yet been devised. The actual amount of expansion is approximately $\frac{1}{4}$ in. on the diameter or $\frac{3}{4}$ in. on the circumference. Several features in connection with the operation of this machine are rather noteworthy. During the operation of filling the pipe, which can be done in approximately 20 seconds, the rate of flow of water is about 1500 gpm. When 16-in., outside diameter, 0.500-in. wall pipe is being expanded, the reactions on the ends of the machine are 300 tons. Practically all the operations are either performed by means of air or hydraulic power and there are a total of 11 hydraulic pumps used to operate this machine.

No indication of the capacity of the various components of the mill has been given. The welding line itself from the unpiler to the outlet from the sizing mill is designed to operate at speeds from 15 to 60 fpm, depending on the size and wall thickness of the material being welded. This size range, incidentally, is from $4\frac{1}{2}$ to 16-in. outside diameter, inclusive, and the range of wall thickness is from 0.187 in. for the smaller diameters to 0.500 in. for the diameters $8\frac{5}{8}$ to 16 in. outside diameter, inclusive. The cut-off machines have a capacity of 30 pieces per hour on 16-in. outside diameter. For smaller sizes, the capacity of these machines is correspondingly greater. The expanding machine has a capacity of 30 pieces per hour on 16-in. outside diameter and correspondingly greater output for smaller sizes. So far as length is concerned, all the units in the mill are designed to handle pipe ranging from a minimum of 17 ft to a maximum of 51 ft in length, with the exception of the welding unit which should not be operated on material shorter than 35 feet in the interests of good speed control. However, when 17 to 20 ft lengths are required, it is more economical, from every point of view, including production, yield, and handling, to weld the pipe in double lengths and cut them in two after welding. Since most of the short length pipe occurs in sizes $8\frac{5}{8}$-in. outside diameter and under, where the large volume of merchant pipe business occurs, there are two cut-off machines covering a range of $4\frac{1}{2}$ to $8\frac{5}{8}$-in. outside diameter arranged in tandem and operated by one man for use in cropping and cutting to length where single lengths are required.

TREATMENT OF BRICK
to Prevent CO Disintegration

By JAMES A. SHEA
General Supervisor of Research
Carnegie-Illinois Steel Corp.
Gary, Indiana

. . . . paper presented at joint meeting of Blast Furnace and Coke Associations of the Eastern States and the Chicago District at Chicago, Ill., November 3, 1950 . . . .

▲ MOST operators are probably quite familiar with carbon monoxide disintegration of blast furnace bricks. However, for those who are not familiar with this phenomenon, a brief explanation is in order. Carbon disintegration of the fireclay bricks in a blast furnace lining is caused by carbon monoxide of the blast furnace gases entering the bricks and depositing carbon around iron oxide particles in the bricks according to the reaction: $2\ CO \longrightarrow C + CO_2$. The iron oxide particles act as a catalyst. The growing carbon deposits crack or disintegrate the brick. The catalytic reaction proceeds most rapidly in the temperature range of 800 F to 1100 F, so the greatest damage to a blast furnace lining will occur in the portions of the linings where these temperatures are encountered.

Prior to 1930, linings were often extensively damaged by such carbon deposition in the bricks. In some cases the pressures developed by carbon deposition would split the furnace shells and in many cases the linings would fail at low tonnages, Figure 1. This photograph shows the condition of the brickwork taken from a Gary furnace in 1926. Much of the inwall lining of this furnace was in a pulverized condition, which caused the lining to fall into the furnace after the stock was removed. Several carloads of the pulverized brick were removed from the furnace.

As a result of the early work on disintegration, blast furnace brick were materially improved, chiefly through improved firing. However, even with the improved brick, a zone of cracked or disintegrated brick could be found in most used linings, Figure 2. This figure shows the peeling of a blast furnace lining through a disintegrated zone 6 to 10 inches behind the working face of the lining. After the lining wore back to the disintegrated zone at a low level in the stack, sections of lining at higher levels and in front of the disintegrated zone began to peel off and fall into the furnace.

The equipment shown in Figure 3 is used at Gary Steel Works for testing blast furnace bricks for resistance to carbon monoxide disintegration. With this equipment, a disintegration test can be made in about 40 hours. This, and other similar equipment, was used in developing the methods of treating bricks to prevent disintegration.

Early attempts to remove the iron in bricks by treating them with hydrogen chloride gas at elevated temperature were only partly successful. Such a procedure would probably work, but might not be practical.

Figure 1 — Disintegrated brick from a blast furnace lining.

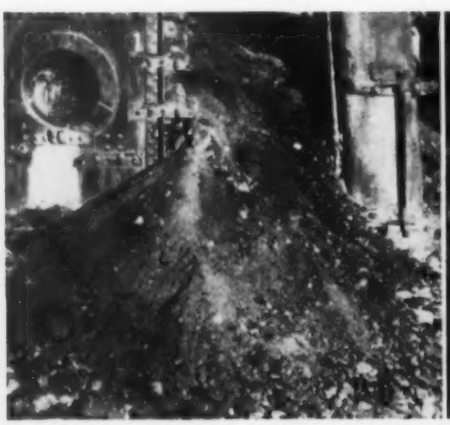


Figure 2 — Peeling of a blast furnace inwall lining.

Figure 3 — Disintegration test equipment.

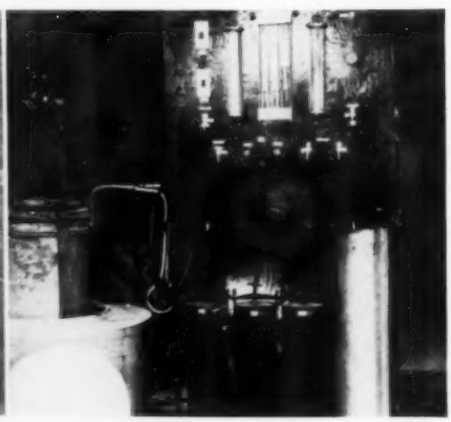


Figure 4 — Untreated high duty brick specimens after testing.

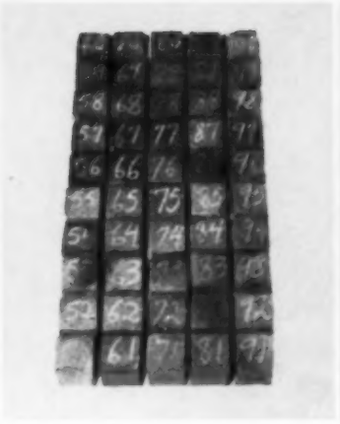


Figure 5 — Sulphuric acid treated high duty brick specimens after testing.

Figure 6 — Disintegration-susceptible specimens after testing.

Figure 7 — Ammonium sulphate treated disintegration-susceptible specimens after testing.

The initial treatment, which was successful and which led to the development of a number of other practical treatments, consisted of dipping a sample of a disintegration — susceptible brick in a 10 per cent solution of sulphuric acid. After drying and heating to 1000 F to drive off excess acid, this treated sample was tested for disintegration for 40 hours without being affected. After this initial test, the sulphuric acid treatment was tried on a larger scale. Fifty representative high duty bricks were cut to provide two duplicate sets of 50 samples. One set of samples was soaked in a 10 per cent solution of sulphuric acid, dried, and heated to 1000 F prior to being tested for disintegration, while the other set was tested in the untreated condition. Figure 4 shows the condition of the 50 untreated specimens after a 40-hour disintegration test. Twenty-six of the specimens were disintegrated, ten were badly cracked, and eleven were cracked to a lesser degree. Figure 5 shows the condition of the acid treated specimens after a 40-hour disintegration test. The treated specimens were not affected by the test.

Similar results were obtained by treating specimens from selected disintegration-susceptible blast furnace bricks with ammonium sulphate, aluminum sulphate, or hydrogen sulphide. Figure 6 shows the condition of twelve untreated specimens from disintegration-susceptible brick after a 40-hour disintegration test. All of the specimens were affected by the test. Duplicates of these specimens, soaked in 30 per cent ammonium sulphate and tested for disintegration, are shown in Figure 7. The ammonium sulphate treatment was completely effective in preventing disintegration. Adequate protection against disintegration can be obtained without soaking the bricks in the treating solution. The disintegration-susceptible specimens shown in Figure 8 were treated by pouring 45 per cent ammonium sulphate solution over the top surfaces before they were tested for disintegration. This procedure was effective in preventing disintegration.

The effectiveness of a treatment with aluminum sulphate solution is illustrated by Figure 9. These disintegration-susceptible specimens were soaked in 30 per cent aluminum sulphate solution before being tested. The specimens were not affected by the 40-hour test.

Treating the bricks with hydrogen sulphide gas at elevated temperatures was found to be an effective method of preventing disintegration. Figure 10 shows the condition of hydrogen sulphide treated specimens of disintegration-susceptible brick after a 40-hour disintegration test. These specimens were heated to 950 F and exposed to hydrogen sulphide gas for 30 minutes before being tested for disintegration. There was no damage to any of the specimens.

Figure 8 — Disintegration-susceptible specimens with ammonium sulphate solution poured on samples before testing.

Figure 9 — Disintegration-susceptible specimens, aluminum sulphate treated before testing.

Figure 10 — Disintegration-susceptible specimens treated with H_2S gas before testing.

Figure 11 — High duty brick specimens after a 40-hr disintegration test.

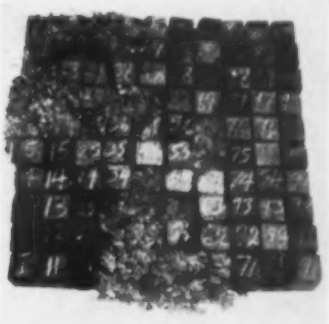


Figure 12 — Treated high duty brick specimens after a 40-hr disintegration test.

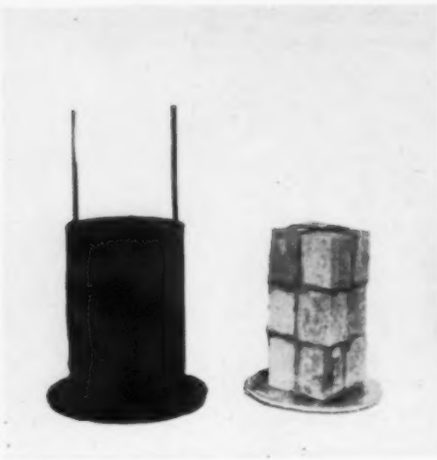


Figure 13 — Column prepared for testing.

Figure 14 — Column test with untreated bond.

A number of other sulphur and chloride compounds were found to be effective in preventing disintegration of blast furnace bricks. Among those found to be effective were:

CS_2 gas.
20 per cent cobalt sulphate solution.
Saturated manganese sulphate solution.
Ethyl sulphate.
30 per cent ammonium persulphate solution.
20 per cent sodium thiosulphate solution.
30 per cent ammonium sulphite solution.
20 per cent sodium bisulphite solution.
30 per cent ammonium thiocyanate solution.
30 per cent magnesium chloride solution.
30 per cent calcium chloride solution.
20 per cent nickel chloride solution.
30 per cent manganese chloride solution.
30 per cent zinc chloride solution.
30 per cent lithium chloride solution.
30 per cent cobalt chloride solution.
Saturated potassium chloride solution.

Many other chemicals were found to be more or less effective.

The normal burned high duty inwall bricks used in relining a Gary blast furnace were treated with a 30 per cent ammonium sulphate solution. This was accomplished by passing the bricks through a stream of the solution as they moved down a roller conveyer to the floor of the furnace. Samples of the bricks used in this lining were tested for disintegration; some in the untreated condition and some after the ammonium sulphate treatment at the furnace. Figure 11 shows the condition of 100 samples of the untreated brick after a 40-hour disintegration test. Twenty-five of the samples were classed as disintegrated, 57 as badly cracked, 17 as cracked, and one as spalled. The results of this test showed the bricks to be quite susceptible to damage by carbon deposition. Figure 12 shows the condition of 45 ammonium sulphate treated specimens after a 40-hour disintegration test. Only one of the 45 specimens was affected by the test. The corner was spalled from Specimen No. 28. Judging from these results, the treatment appeared to be effective.

The treated inwall lining of this furnace was core drilled after being on blast for eleven months. No indications of disintegration were found in the lining, and the core samples passed a 40-hour disintegration test without being affected. From these results, it appears that the treatment is effective for a year or more. The treated lining is to be examined and tested for disintegration on completion of its campaign. As a word of caution, it should be pointed out that zones of

Figure 15 — Column test with ammonium sulphate treated bond.

Figure 16 — Column test with aluminum sulphate treated bond.

Figure 17 — Column test with 5 per cent sulphuric acid treated bond.

Figure 18 — Hard burned high duty brick specimens after a 40-hr disintegration test.

localized wear, sometimes referred to as hot spots, can develop in either treated or untreated linings. Although the treating of bricks apparently prevents carbon monoxide disintegration, it should not be regarded as a "cure-all" for all lining troubles.

Treatment with the chemical solutions can be accomplished in a number of ways — soaking, dipping, spraying, or by adding the chemical to the bonding material used in laying the bricks. Figure 13 shows the type of test used in determining the effectiveness of adding chemicals to a sillimanite bond. The brick column on the right was built up with specimens of disintegration-susceptible brick using a sillimanite mortar as a bond. The column was then tested for disintegration in the chamber shown at the left. Figure 14 shows the column, with no chemical added to the sillimanite bond, after a 40-hour test. All of the specimens were disintegrated or cracked and the column was disrupted. Figure 15, shows a column built up of duplicate specimens, but bonded with a sillimanite slurry made up with 45 per cent ammonium sulphate solution instead of water. The 40-hour disintegration test caused only a few superficial spalls on exposed faces of the brick specimens. Similar column tests were made using aluminum sulphate and sulphuric acid in the bond.

Figure 16 shows a column made up with aluminum sulphate in the bond and then tested. Superficial surface spalls occurred on two of the specimens, but there was no cracking or disintegration of the specimens. The use of 5 per cent sulphuric acid solution in the bond instead of water did not completely stop carbon deposition as is shown in Figure 17. In this test some of the specimens were cracked. A stronger acid solution probably would have prevented this cracking.

With chemicals such as H_2S, CS_2, and perhaps some of the other sulphur compounds, blast furnace bricks could be effectively treated in the periodic kilns during the cooling period after the bricks had been fired. With these chemicals, the bricks should be at a temperature in the range 700 to 1500 F when treated.

Temperatures above 1000 to 1300 F in an oxidizing atmosphere will destroy any of these treatments. In a carbon monoxide atmosphere much higher temperatures are required to destroy the effect of the treatments.

Figure 18 shows the condition of 30 specimens of hard burned high duty bricks after a 40-hour disintegration test. These specimens were not affected by the test. Most of the hard burned bricks now on the market are highly resistant to disintegration. If only added resistance to disintegration is required, this can be obtained at less cost by treating regular fired bricks than by buying the higher priced hard burned bricks. However, in most cases, the hard burned bricks have the additional advantages of greater strength and density.

Applications for patents to cover the various chemical treatments have been made.

REPORT TO AISE MEMBERS

Recently the membership was polled for an expression of opinion on whether or not to raise dues or to charge for the bound volume of AISE Yearly Proceedings. Results of this poll showed 54.5 per cent of the replies to favor a dues increase, with 28 per cent opposed; while 48 per cent favored a charge for the book, with 22.9 per cent opposed. Some suggested doing both, while only 91 opposed both forms of increased charge.

Nevertheless, in the light of present business conditions, the AISE directors decided not to increase dues or to charge for the bound volume of the Yearly Proceedings in 1951. However, since copies of the bound proceedings are not needed or wanted by some members, the directors, in order to hold down expense, have decided to send the 1951 book to only those who request it.

Therefore, members who want the 1951 bound proceedings (delivered early in 1952) must fill out the form below or a similar one which is being sent all members with their bill for 1951 dues and return it immediately to the headquarters of the AISE. If no request is received by *January 15, 1951,* a book will not be made up or reserved. Since 1950 books are already in process, they will be distributed early in 1951, as in the past.

Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Pennsylvania

Please Send a 1951 AISE Proceedings to me.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

THE AISE BOOKSHELF

. . . . this is not a complete list of books, nor a list of "best" books . . . . it is merely a collection that has been found to be of great value to many steel plant engineers and operators . . . .

▲ IT is not without considerable temerity that the Association of Iron and Steel Engineers puts forth a recommended list of books. Selection of a list of books has always been more or less of a national pastime among "bookish" individuals, and it is seldom (as we have learned from experience) that two people will agree on a list. Certainly, there can never be complete unanimity of opinion as to which are the "best" books.

In preparing the accompanying list of titles, we have attempted to set up a skeleton library confined pretty closely to the field of activity of the AISE. The list began with a number of titles that were arbitrarily suggested and circulated to a wide cross-section of steel industry people. The list grew mightily in these travels and the problem became one of elimination. With the aid of various specialists and technical librarians, the accompanying list was evolved. It is definitely *not* the literature of the industry, and definitely *not* a complete coverage of any particular section of it, but rather a nucleus to which the specialist in any field must make many additions in that particular field.

It is important for any engineer or operator to be aware of the continuity of the literature—the constantly increasing flow of information in print. Technology is always just a little ahead of the printed page, and a technical book is usually slightly out of date when it comes from the press. More timely information is to be found in the trade journals and in manufacturers' trade literature. For basic reference use, however, the following books are recommended:

GENERAL

Making, Shaping and Treating of Steel.....**United States Steel Corp.**
Proceedings of the Association of Iron and Steel Engineers (annual).....
Yearbooks of the American Iron and Steel Institute (annual).....
Journal of the (British) Iron and Steel Institute (annual).....

COKE PLANT AND BLAST FURNACE

Chemistry of Coal Utilization (2 vol)—Lowry.....**John Wiley & Sons Co.**
Coal, Coke and Coal Chemicals—Wilson and Wells.....**McGraw-Hill Book Co.**
Blast Furnace Practice—Sweetser.....**McGraw-Hill Book Co.**
Proceedings of the Blast Furnace and Raw Materials Committee (annual).....**American Institute of Mining & Metallurgical Engineers.**

STEELMAKING

Basic Open Hearth Steelmaking.....**American Institute of Mining & Metallurgical Engineers.**
Proceedings of the Open Hearth Committee (annual).....**American Institute of Mining & Metallurgical Engineers.**
Manufacture of Electric Steel—Sisco.....**McGraw-Hill Book Co.**
Proceedings of the Electric Furnace Committee (annual).....**American Institute of Mining & Metallurgical Engineers.**

METALLURGICAL

Steel and Its Heat Treatment (3 vol)—Bullens.....**John Wiley & Sons Co.**
Metallurgical Problems—Butts .....**McGraw-Hill Book Co.**

ROLLING AND FORGING

Roll Pass Design (2 vol and supplement)—Trinks.....**Penton Publishing Co.**
Forging Handbook—Naujoks .....**American Society of Metals.**
Theory and Practice of Rolling Steel—Tafel.....**Penton Publishing Co.**
The Rolling of Metals (vol 1)—L. R. Underwood.....**John Wiley & Sons Co.**

FINISHING

Galvanizers Handbook—Daesen	Reinhold Publishing Corp.

ELECTRICAL

Standard Handbook for Electrical Engineers—Knowlton	McGraw-Hill Book Co.
Electrical Engineers Handbook (2 vol)—Pender	John Wiley & Sons Co.
Principles & Practice of Electrical Engineering—Gray-Wallace	McGraw-Hill Book Co.
Industrial Electricity (2 vol)—Timbie and Willson	John Wiley & Sons Co.
Magnetic Control of Industrial Motors—Heuman	John Wiley & Sons Co.
Applied Electronics—Staff of Dept. of Electrical Engineering, M. I. T.	John Wiley & Sons Co.
Electric Transmission and Distribution Reference Book	Westinghouse Electric Corp.

CONSTRUCTION

Data Book for Civil Engineers (3 vol)—Seelye	John Wiley & Sons Co.
Materials of Construction—Johnson-Withey-Aston	John Wiley & Sons Co.

MECHANICAL

Mechanical Engineers Handbook—Marks	McGraw-Hill Book Co.
Mechanical Engineers Handbook (2 vol)—Kent	John Wiley & Sons Co.
Elementary Steam Power Engineering—McNaughton	John Wiley & Sons Co.
Boiler Feed and Boiler Water Softening—Blanning and Rich	Nickerson & Collins.
Fan Engineering—Madison	Buffalo Forge Co.
Air Compressors—Feller	McGraw-Hill Book Co.
Pumps—Kristal and Annett	McGraw-Hill Book Co.
Handbook of Applied Hydraulics—Davis	McGraw-Hill Book Co.
Machine Design—Maleey	International Textbook Co.
Tool Engineers Handbook—Wilson	McGraw-Hill Book Co.
Welding Handbook	American Welding Society.
Heating, Ventilating and Air Conditioning Guide	American Society of Heating & Ventilating Engineers.

LUBRICATION

The Practice of Lubrication—Thomsen	McGraw-Hill Book Co.
Lubricants and Lubrication—Clower	McGraw-Hill Book Co.
Ball & Roller Bearing Engineering—Palmgren	S. H. Burbank & Co., Inc.

FUELS AND FURNACES

Fuels and Their Combustion—Haslam and Russell	McGraw-Hill Book Co.
Fuels, Combustion and Furnaces—Griswold	McGraw-Hill Book Co.
Industrial Furnaces (2 vol)—Trinks	John Wiley & Sons Co.
Heating of Steel—Mawhinney	Reinhold Publishing Corp.
Refractories—Norton	McGraw-Hill Book Co.
Industrial Instruments for Measurement and Control—Rhodes	McGraw-Hill Book Co.
Industrial Instrumentation—Eckman	John Wiley & Sons Co.
Coal Preparation—Mitchell	American Institute of Mining & Metallurgical Engineers.

INDUSTRIAL ENGINEERING

Industrial Management—Lansburgh and Spriegel	John Wiley & Sons Co.
Motion and Time Study—Barnes	John Wiley & Sons Co.
Statistical Quality Control—Grant	McGraw-Hill Book Co.
Practical Job Evaluation—Jones	John Wiley & Sons Co.

CHEMICAL

Chemical Engineers Handbook—Perry	McGraw-Hill Book Co.

MISCELLANEOUS

Plant Engineering Handbook—Staniar	McGraw-Hill Book Co.
Handbook of Engineering Fundamentals—Eschbach	John Wiley & Sons Co.
Mining Engineers Handbook (2 vol)—Peele	John Wiley & Sons Co.
Industrial Health Engineering—Brandt	John Wiley & Sons Co.
Accident Prevention Manual	National Safety Council.
Business, Legal and Ethical Phases of Engineering—Canfield and Bowman	McGraw-Hill Book Co.
Writing the Technical Report—Nelson	McGraw-Hill Book Co.
How to Supervise People—Cooper	McGraw-Hill Book Co.
How to Speak Effectively—G. E. Peabody	John Wiley & Sons Co.

ORE UNLOADER BUILT ON EAST COAST

. . . . new foreign ore supplies require additional port ore facilities . . . .

By W. B. MacLEAN
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Dravo Corp.
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▲ PLANS for increasing importation of iron ore from Liberia and South America has created a need for the construction of new materials handling equipment to unload ore at east coast ports. Because of the corrosive influences of salt water and salt air in seaboard areas, special measures must be taken in designing these unloaders to provide maximum performance with minimum maintenance requirements.

A 15-ton unloader for the east coast features the combined use of welded and riveted construction.

An ore unloader is a huge piece of operating machinery, parts of which, under normal conditions, may receive 20 to 30 million stress cycles during its service life. Seal welding which completely protects joints is effective from the standpoint of corrosion resistance. But laboratory tests have shown fillet welded members have low fatigue value where subject to serious stress fluctuations or reversals. That is why it was decided to employ riveted construction for the runway portion of the unloader where fatigue is a vital factor. The tower of the unloader, however, is not subjected to stress fluctuations from live loads as great as those in the runway. Therefore, the tower of this new unloader was welded.

The unloader consists essentially of a center tower section, approximately 125 ft high, and a 210-ft long horizontal runway carrying the trolley track. See Figure 1. The front, or apron, part of the runway extends over the harbor area so the bucket has access to ships' holds. The rear, or cantilever, part extends over the ore storage area. Total weight of the unloader in operating condition with the bucket empty is 646 tons, and the weight of the moving trolley, is 94 tons. Normal capacity of the bucket is 15 net tons (30,000 lb) of ore weighing 150 lb per cu ft.

TRUCKS

The unloader travels on two double rail tracks 46 feet center to center. It is carried on four 8-wheel trucks, one at each corner of the tower. The load is fully equalized over all wheels by a system of rocker bars and equalizing beams. Truck equalizers are of cast steel and the main equalizers are of all welded beam and plate construction. All eight wheels at each corner are driven by independent 45-hp motors suspended beneath the sill structure. Each motor drives through a worm gear reduction unit for each pair of axles and thence by spur pinion and gear to each axle. A safety arrangement limits the drop of the truck to 1 in. in case of axle failure.

TOWER

Between the runway tracks, there are three standard gage railroad tracks. The lower portion of the tower is constructed in the form of a portal to clear ore trains and other rolling equipment on these tracks. The all-welded tower structure is built entirely of rolled steel shapes. No lacing is used. Splices in main columns are butt welded wherever possible and bracing members generally are fillet welded to gusset plates. All main connections were seal welded to prevent corrosion at the faying surfaces.

RUNWAY AND APRON

The trolley runway consists of two modified Warren trusses 9 ft 9 in. deep and 13 ft 7 in. center to center, the main members being of 18 in. low alloy steel. At each panel point there is a transverse yoke which supports the rail stringer. Lateral bracing is provided in the plane of the top chords. Figure 1 shows a cross-section of the truss and yoke. The rail stringers are canted inward on a slope of 1 in 40 to bring center of pressure over center of rail. This results in smooth tracking of the trolley. The apron forms part of this runway and is similar in construction to the fixed portion. It is hinged at its inner end and suspended on two sets of linked eyebars, so it can be raised by hoist to clear a ship's rigging while moving along the dock. A structural steel latch at the top of the tower securely holds the apron against movement in either direction when raised. To reduce dead weight of the apron, low alloy steel was used for yokes and the top chord and diagonals of the truss.

The hoist for raising and lowering the apron is on top of the tower. It is operated by an electric motor driving through worm gear and spur gear reductions to a welded steel rope drum. The drum is grooved to receive all of the rope in one layer. Safety interlocking by limit switches is provided between the latch and the hoist. The hoist is in a corrugated sheet metal house which also contains the electrical control panels and resistors for the tower travel motors.

At each end of the runway, a spring buffer is provided for emergency stopping. Speed and travel is further protected by limit switches. At the water leg of the tower a movable buffer automatically drops into place across the trolley track as the apron is raised. Even though the apron may be in the raised position ore can still be loaded from the storage area under the rear cantilever to cars on either of the two landward tracks under the portal.

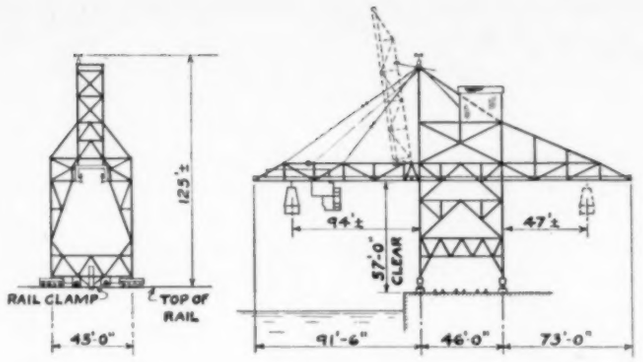
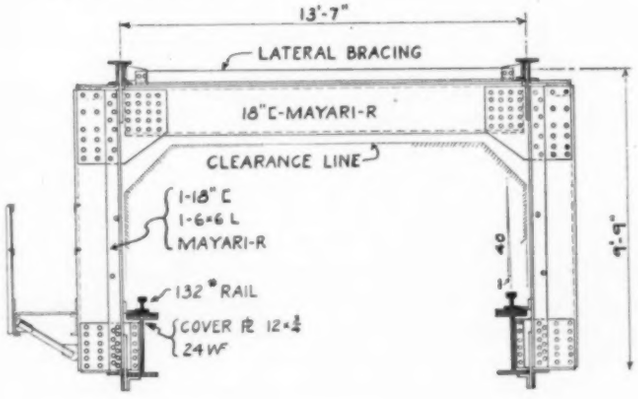


Figure 1 — This sketch shows outline and main dimensions of new ore unloader on the east coast. Design capacity of the equipment for free digging on an average cycle from ship holds to storage pile is 1100 net tons per hr of ore weighing 150 lb per cu ft.

Figure 2 — Cross-section of the truss and yoke of the trolley runway.



TROLLEY

The trolley is a heavy welded steel frame approximately 12 ft wide by 34 ft long. It supports a two-motor hoist for the bucket and two trolley drive mechanisms. Suspended from the trolley is a two-story all-welded sheet metal control house. The upper story houses electrical control boards and resistors for hoist and trolley travel and the lower story is the operator's cab.

The trolley frame was completely fabricated before any machining was performed to provide the best foundation possible for alignment purposes. As a result it functions as a large bed plate for mechanical equipment. The frame is spring mounted on four single flanged, tapered tread wheels accurately machined.

The trolley drive motors are mounted on welded steel cradles fastened to two points on the axle through anti-friction bearings and to a third point on the trolley frame through a flexible connection. This allows for flexing of the supporting springs without misalignment of gearing. These motors are 125-hp each. At each corner of the trolley there is a safety lug to prevent the trolley from dropping more than 1 in. in case of axle failure. Liberal use was made of low alloy steel to reduce dead weight, its increased strength and high resistance to corrosion being advantageous in this application. In the axles and drive shafts, fillets have as large a radius as possible to minimize stress raisers as insurance against fatigue failure.

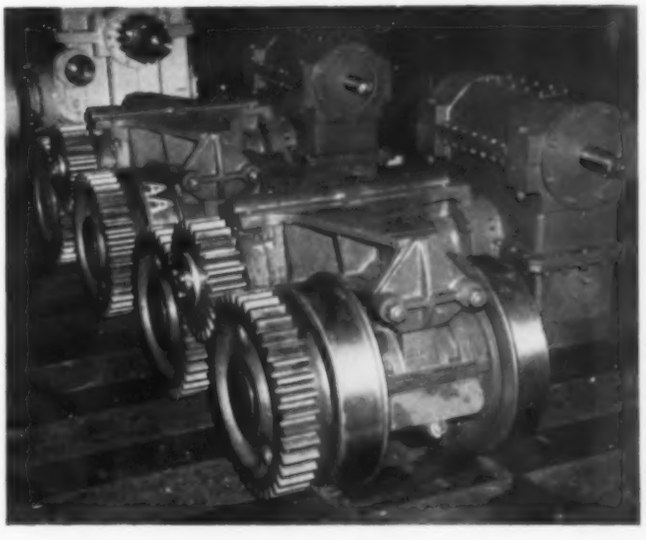
While the main digging bucket is of 15-ton capacity, the trolley also is arranged for a 7½-ton bucket used in small hatches and clean-up work. A motor driven turntable is incorporated in the trolley frame whereby the operator may rotate the smaller bucket to suit digging conditions. This is accomplished by connecting two of the bucket ropes to the drums and dead-ending the other two on the turntable. Thus when the turntable rotates, the bucket follows suit.

The 250-hp hoist motors each drive a welded steel grooved drum through double reduction gearing.

As a safety feature against wind storms two automatic self-aligning rail clamps are mounted at the center of the sill structures. These can hold the un-

Figure 3 — Located on the east coast, this new 15-ton unloader for imported iron ore features combination welded and riveted construction to achieve maximum functional ability with minimum maintenance in a salt air region.

Figure 4 — Closeup shows one of the four eight-wheel truck assemblies which carry the unloading tower. An independent 45-hp motor drives each truck through worm gear reduction units for each pair of axles and by spur pinion and gear to each axle.



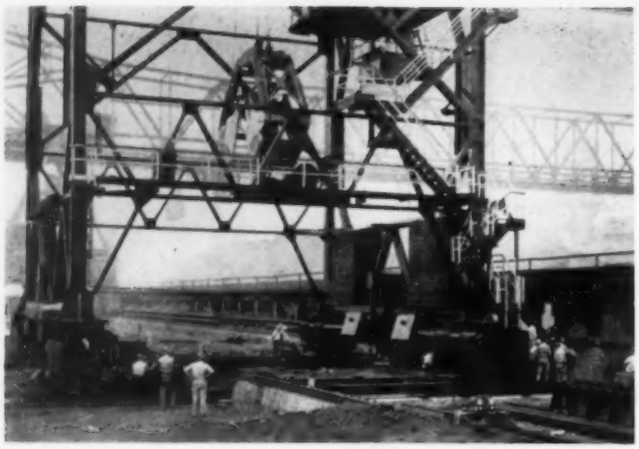


Figure 5 — Dock runway where the new unloader was transferred from rollers to the permanent dock rails. The tower travel speed is 90 fpm on the double-track rails, which are on 46 ft centers. Unloader is carried on four eight-wheel trucks, independently driven by 45-hp motors.

loader against a 45 lb per sq ft (106 miles per hour) wind without the brakes on the drive motors.

FABRICATION AND ERECTION

Each apron truss was shop-assembled and shipped in one piece. The fixed runway trusses were shipped in two pieces each. The corresponding length of rail stringer was included as part of the truss assembly. The tower structure was shipped virtually knocked down. The bracing trusses used near the bottom of the tower were within railroad clearances and could be shipped assembled.

Since the runway for this unloader also is used by other unloaders and several ore bridges, erecting the new one without interfering with the operation of the other equipment presented a serious problem. This was solved by erecting the unloader in an unused area beyond the end of the dock and off to one side of the runway. After completion, the structure was rolled endwise on especially prepared concrete slabs to the dock runway.

The unloader is operated on 230 volt d-c current and all control is of the full magnetic type. Limit switches prevent overtravel of the bucket and trolley. The rail clamps are interlocked with the drive motors and the apron hoist control is interlocked with the apron latch to prevent errors in operation. An anemometer mounted on top of the tower is arranged to shut off the tower travel motors and apply the rail clamps and motor brakes, and to set up a dynamic braking circuit whenever the wind exceeds a velocity of about 42 miles per hour (7 lb per sq ft).

Design speeds of the several motions are as follows:

Tower travel—90 fpm.
Trolley travel—1200 fpm, balanced speed.
Bucket hoist—250 fpm.
Turntable—9 rpm.
Apron hoist—7 min. to hoist.

Design capacity of the unloader for free digging on an average cycle from ship's hold to storage pile is 1,100 net tons per hour of iron ore weighing 150 lb per cu ft. Working with existing equipment to unload ships bringing foreign ore to the plant, the new unloader helps reduce turn-around time for ore boats and is a contributing factor in the ever-increasing volume of steel production utilizing foreign ores.

REPORT ON COKING TESTS ON WEST VIRGINIA COALS

▲ Carbonization studies on four West Virginia coals from the Eagle, No. 2 Gas, Pocahontas No. 3 and Pocahontas No. 4 beds show that these fuels are suitable for the manufacture of oven coke if blended in the proper proportions, according to a report released today by James Boyd, Director of the Bureau of Mines. The report represents part of the Bureau's continuing investigation of the coking properties of American coals, and is entitled : Bulletin 493, "Carbonizing Properties, West Virginia Coals from the Eagle, No. 2 Gas, Pocahontas No. 3 and Pocahontas No. 4 Beds." It may be obtained from Superintendent of Documents, U. S. Government Printing Office, price $0.30.

Samples used during the study were taken from the Lake Superior No. 3 mine, McDowell County, W. Va., No. 3 bed; Lake Superior No. 4 mine, McDowell County, W. Va., No. 4 bed; Cannelton No. 3 mine, Fayette County, W. Va., Eagle bed, and the Cannelton No. 100 mine, Kanawha County, No. 2 Gas coal bed. The Eagle and No. 2 Gas coals were high-volatile A, while the Pocahontas No. 3 and 4 coals were in the lower-volatile classification.

Most important of the Pocahontas group is the No. 3 bed which attains minable thickness and purity over an area of about 650 square miles. However, the No. 4 bed extends over an area of 155 square miles in Wyoming and McDowell Counties. These reserves, which have been reduced by extensive mining, have been estimated at 800,000,000 tons for the No. 4 bed and 2,800,000,000 tons for the No. 3 bed. The Pocahontas beds have supplied most of the low-volatile coal carbonized in ovens, and the curtailment of the reserves has caused concern among coke-plant operators.

How to Evaluate a Crane Proposal

By F. M. BLUM
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. . . paper presented at the third biennial Materials Handling Conference sponsored by Westinghouse Electric Corp., Buffalo, N. Y., October 24 and 25, 1950 . . . .

▲ THE average plant engineer or purchasing agent, unless connected with a large company, will purchase no more than one or two cranes in his lifetime. These men really cannot make a study of crane construction and, therefore, must rely upon some means of coming to a decision. Such decisions usually are made upon the impression gained from the crane salesman's discussions of his proposal, or the analysis of tabulation of competitive bids, or, thinking all cranes being equal, purchase is based on low price or on a price-per-pound basis. All of this is not very assuring.

Overhead traveling cranes are not purchased on the same basis as small tools or, like automobiles, say for a five-year life expectancy. Overhead traveling cranes of the industrial type last for 40, 50, and 60 years. On production cranes such as magnet cranes, bucket cranes, or cranes having a definite duty cycle to perform each day, the average life expectancy is from 25 to 30 years. It can, therefore, readily be understood how the inexperienced buyer could be misled to purchasing a piece of equipment on a low bid or on a price-per-pound basis which might be troublesome and costly to maintain for the entire life of the crane.

In the last two years, 32 per cent of all cranes purchased were bought on the low bid basis. To those people who have bought and intend to buy on a low bid basis, I would like to dedicate this paper. It is unwise to pay too much. It is worse to pay too little. When you pay too much you lose a little money and that is all, but when you pay too little you stand a chance to lose everything, because the crane that you are buying may prove incapable of doing the very job that it was bought to do. The basic principles of business balance make it impossible to pay a little and get a lot. It sometimes may be advantageous to deal with the lowest bidder, but when you buy on price alone, it is well to set aside a reserve as a matter of self-protection in case the crane should fail to meet your full requirements. Take the price quoted by the lowest bidder, add to it an amount of money sufficient to cover the chance you are taking, and you may find that

Figure 1 — This "Class 1" power house crane installation is at a substation on the west coast.

Figure 2 — These "Class 2" cranes illustrate economical installation and an efficient selection for light duty service.

the sum of the two is enough to buy known quality at the outset.

There are crane buyers who tabulate bids and buy on the price-per-pound basis. This is no longer an accurate way to judge the purchase of an overhead traveling crane. The modern crane today with welded girders instead of riveted girders, welded end trucks instead of cast and riveted end truck construction, welded trolley sides instead of cast trolley sides, and welded drums instead of cast drums, has been designed to produce a crane having a lower dead weight than its ancestors. As an example, a 20-ton, 65-ft-span crane built in the late 20's weighed 73,000 lb. A duplicate of that crane except for such modern improvements as welded design, but the same lifting capacity, the same factor of safety, and with the same speeds, at the present day weighs only 61,400 lb. Yet, this crane which has to lift 20-ton live load, itself weighs over 30 tons. Therefore, it readily can be seen that modern trends are to reduce the dead weight of the crane, and correspondingly one should not purchase an overhead traveling crane on the basis of price per pound — no more than one would think of buying a milling machine or a boring bar on the basis of price per pound. You are not buying so much cast iron, nor so much structural steel. You are buying a machine tool to do a certain job.

It is, therefore, obvious that the only fair means of evaluating crane bids is by tabulation of certain pertinent features of the cranes. To give a true evaluation of the bid tabulation, however, a knowledge of some basic principles of crane design is necessary. A few years ago, we presented before this same forum a paper in which we outlined certain classifications of cranes dependent upon duty service classification. The basic principles presented in that paper are still in use today, and we believe it would be well to repeat some of these classifications for the crane buyer. Crane service classifications,* as used by our sales and engineering departments to evaluate opinions where exactness of duty cycle is not possible to anticipate, are as follows:

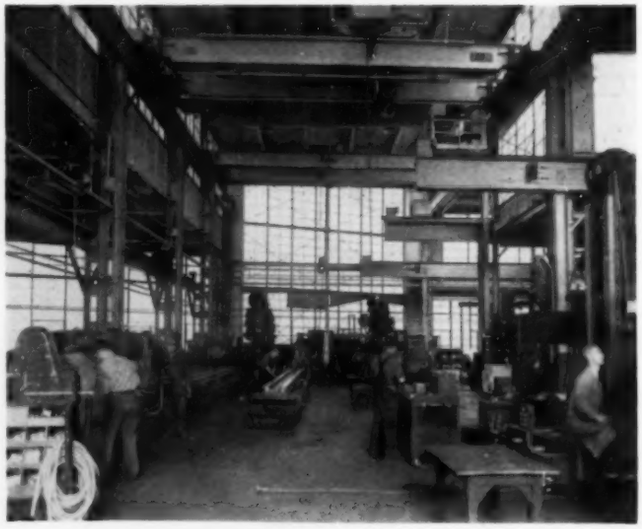
Class 1 cranes are used for standby duty such as in powerhouses and motor rooms. This type of crane usually is provided with slow speeds because of occasional use involved in this type of service. The service life of the equipment is equal to the minimum operating standards and the maximum demand of full load lifts per hour in the neighborhood of 2 to 5. See Figure 1.

Class 2 cranes are for light duty service, such as machine shops, warehouses, etc. In this instance, the moderate speeds and infrequent lifts call for service life of the parts and equipment to be comparable to the service expectancy. Maximum demand of full load lifts per hour is somewhere between 5 and 10. See Figures 2 and 3.

Class 3 cranes are for moderate duty such as light foundry, storage yards, etc. With the average speeds and intermittent lifts encountered in this service, the service life of the parts and equipment should be equal to normal requirement. Maximum demand of full load lifts per hour is equal to about 10 to 20. See Figure 4.

Class 4 cranes are for constant heavy-duty service such as encountered in heavy foundry work and production line cranes. With fast, constant operation, the

Figure 3 — These floor operated units are included in the "Class 2" category and are only subjected to moderate speeds and infrequent lifts.



**Editor's Note:* For another somewhat similar method of evaluating crane service, see Association of Iron and Steel Engineers' "Specifications for Electric Overhead Traveling Cranes for Steel Mill Service" — AISE Standard No. 6, May 1, 1949, particularly paragraphs 34, 36, and Tables 43-II and 43-III.

service life of the parts and equipment must be such as to equal the sustained service requirements. Maximum demand of full load lifts per hour equals somewhere between 20 and 40. See Figure 5.

Class 5 cranes are for very severe duty, such as used for magnet operation, grab buckets, stockyards, etc. Here, the fast and extra fast speeds together with steady use call for service life of parts and equipment to include rugged construction for maximum operating conditions. Maximum demand of full load lifts per hour is somewhere between 40 and 80.

These five classifications of cranes based upon the duties they are to perform best can be illustrated and translated into load ratings of the crane manufacturer's trolley and bridge drives. For instance, the typical loading on the 20-ton trolley frame for service classifications would be as follows:

Class 1 — Standby duty	
150 per cent of nominal load rating	**30 ton**
Class 2 — Light duty	
125 per cent of nominal load rating	**25 ton**
Class 3 — Moderate duty	
Nominal load rating	**20 ton**
Class 4 — Constant duty	
75 per cent of nominal load rating	**15 ton**
Class 5 — Severe duty	
50 per cent of nominal load rating	**10 ton**

In other words, with a 20-ton pattern trolley, the crane builder can build a 10-, 15-, 20-, 25-, or 30-ton crane, depending upon the service for which the crane is desired.

Therefore, the crane builder, by proper selection of these capacity frames, will provide engineering designs for the entire field of crane capacities, and will be adequately covered for service requirements without having special or overlapping patterns, or by leaving service demand gaps. Such nominal ratings in frame sizes cover 5-, 10-, 20-, 30-, 50-, 75-, and 125-ton pattern sizes. It is interesting to note in the selection of trolley patterns by the crane manufacturer, that his nominal load rating for that particular trolley size, or for Class 3 cranes, the basic drum diameter for the cable used at that particular rating provides him a factor of safety of 5 on the cables, and provides him with a drum diameter that is at least equivalent to 30 rope diameters. Here, we have one of the basic principles of crane design — one of the vital factors in evaluating bids on overhead traveling cranes.

Let us investigate further some of the basic principles of crane design, so that we will be in a better position to evaluate bids. For the bridge drive, the maximum wheel load on the crane and the speed determines the size of bridge wheels to be used. The physical proportions of the wheels will keep the loadings well within the permissible limits. The ratings on the individual wheels and bearings used on wheel axles do not vary too greatly between various manufacturers. However, the bearing sizes used for these wheel loads provide certain life hours which certainly should be taken into consideration in evaluating crane bids. It is our general practice to provide service life for the bridge and trolley drives for anti-friction bearing cranes, based upon certain load factors to obtain these bearing life hours. The following bearing life hours are used for various crane classifications:

Class 1 — 3,000 hours minimum	**Load factor 1.25**
Class 2 — 5,000 hours minimum	**Load factor 1.00**
Class 3 — 15,000 hours minimum	**Load factor 0.75**
Class 4 — 30,000 hours minimum	**Load factor 0.60**
Class 5 — 50,000 hours minimum	**Load factor 0.50**

The basic bridge wheel diameters are as follows: 15, 18, 21, 24, 27, and 30 in. Therefore, each of these wheel diameters has a bridge drive unit designed for it to provide a certain life expectancy under certain imposed wheel load conditions and bridge speeds. The diameter of the cross shaft and the diameter of the axles, are proportionately designed to this wheel diameter and horsepower requirements and, most important of all, the bridge bearing life of the truck axle bearings is determined on the basis of the size of bearing possible to install on the truck wheel shaft. Therefore, from a machinery standpoint, we have the basis of judging and evaluating the bridge for our contemplated crane purchase. Briefly, then, let us tabulate the highlights of the bids and attempt to evaluate these bid items. For this tabulation, let us suggest a 20-ton crane with a 5-ton auxiliary, 90-ft span with a 35-ft lift, to be used for, let us say, machine shop service and what is known as a "standard industrial crane." Let us also assume that the current supply available is 230 volts d-c. If we compare the hoist speeds for bidder "A" and "B" they are identical, 25 fpm on the main hoist and 54 fpm on the auxiliary hoist. The horsepower on the hoist motors and the rating of hoist motors also are identical. The computed horsepower required is identical for both bidders for the main and auxiliary. It is well to note here that some variation in manufacturers exists in the computing of hoist motors, and this particularly is in the assumed efficiency of the gear train and the efficiency of the ropes and sheaves. However, no great variation should exist, but in some cases it may fall within the difference between one motor rating and another. In all cases it is advisable to overmotor the crane in the hoist motion, rather than to undermotor it.

In looking at the next item, number and parts of rope, we find that bidder "A" on his main hoist has provided 8 parts of $\frac{5}{8}$-in. rope. In checking this, we find that the $\frac{5}{8}$-in. cable is rated by the cable manufacturers as being sufficient to hold 16.6 tons. This, times 8 parts of rope, and divided over a safety factor of 5 provides 24 tons for this $\frac{5}{8}$-in. cable, which is better than a factor of safety of 5, since the rated capacity required is only 20 tons. In case of bidder "B," he is using 8 parts of $\frac{9}{16}$-in. rope. This rope is rated at 13.5 tons, times 8 parts of rope, and divided by a factor of safety of 5, giving 21.6 tons — which is just within the factor of safety of 5. Checking back, then, we find that bidder "A" on the main hoist has actually a factor of safety of 6 on the ropes in comparison to a factor of 5 for bidder "B." On the auxiliary hoist, bidder "A" has specified that he is using 4 parts of $\frac{1}{2}$-in. rope. This $\frac{1}{2}$-in. rope is good for 10.8 tons, times 4 parts rope, and divided by 5, indicating that the tonnage on this particular reeving is 8.64 tons. Bidder "B" has used $\frac{3}{8}$-in. rope, which has a tonnage of 6.3 per rope, times 4 parts rope, and divided by 5, indicating 5.04 tons. Therefore, it clearly indicates that bidder "A" has better than a factor of safety of 8 on the auxiliary hoist

ropes, whereas bidder "B" has a factor of only 5. Both bidder "A" and "B" have specified 6/19 improved plow steel rope.

However, under Item 6, we again come to a very vital point in determining and making an analysis of our typical crane bid. Hoisting drums should be, as mentioned before, at least 30 rope diameters. The 5/8-in. rope specified for the main hoist by bidder "A" means that a minimum drum diameter of 18¾-in. is required; therefore, the 20-in. drum that he has specified exceeds the 30 minimum rope requirements. Bidder "B" has specified a 15-in. drum, and 30 times of 9/16-in. rope diameter is 16.86-in. diameter minimum requirement. Therefore, the 15-in. drum which bidder "B" has specified is less than 27 times rope diameter. Therefore, it clearly indicates that bidder "A" on the main hoist, from a standpoint of rope size and safety factor, is providing more crane than bidder "B."

On the auxiliary hoist, Bidder "A" has provided ½-in. rope which requires a 15-in. diameter drum and he has specified it; therefore, the requirement to provide 30 rope diameters has been met. Bidder "B" has specified 3/8-in. rope, which means that a minimum diameter of 11.25 in. is required for 30 rope diameters; the 10-in. drum which he has specified is less than 27 times rope diameter.

	Bidder A		Bidder B	
GENERAL:				
1. Capacity	20/5 ton		20/5 ton	
2. Span	90 ft 0 in.		90 ft 0 in.	
3. Lift	35 ft 0 in.		35 ft 0 in.	
4. Total net weight	88,000 lb		77,000 lb	
	Main hoist	**Aux hoist**	**Main hoist**	**Aux hoist**
HOISTS:				
1. Hoist speed, fpm	25	54	25	54
2. Hp of hoist motor and 30 minute, 55 C rating	40 hp	20 hp	40 hp	20 hp
3. Computed hp required	39	19.7	39	19.7
4. Number and parts of rope	8 parts 5/8 in.	4 - ½ in.	8 - 9/16 in.	4 - 3/8 in.
5. Type of wire rope	6/19 imp plow steel	6/19 imp plow steel	6/19 imp plow steel	6/19 imp plow steel
6. Diam of hoist drum, in.	20	15	15	10
7. Material in drum	Welded steel	Cast iron	Cast iron	Cast iron
8. Type of bearings	Roller	Roller	Roller	Roller
9. Make and type of gears and pinions	Spur gears welded steel Forged steel pinions	Spur gears welded steel Forged steel pinions	Spur gears welded steel Forged steel pinions	Spur gears welded steel Forged steel pinions
10. Material of gears and pinions	Gears SAE-8630 Pinions SAE-8742 Heat treated Hardened	Gears 8630 Pinions 8742 Heat treated Hardened	Gears SAE-1040 Pinions SAE-1045	Gears SAE-1040 Pinions SAE-1045
TROLLEY:				
1. Trolley speed, fpm	200		125	
2. Hp of trolley motor and rating	7½		3	
3. Computed running hp required	3.5		1.96	
4. Service factor used	2.14		1.53	
5. Diam of trolley wheels, in.	13½		12	
6. Spread of trolley	8 ft 0 in.		7 ft 0 in.	
7. Type of bearings	Roller		Roller	
8. Make and type of gears and pinions	Welded spur gears Forged steel pinions		Welded spur gears Forged steel pinions	
9. Material of gears and pinions	Gears SAE-8630 Pinions SAE-8742 Heat treated hardened		Gears SAE-1040 Pinions SAE-1045	
10. Weight of trolley complete, lb	18,400		13,000	
BRIDGE:				
1. Bridge speed, fpm	300		300	
2. Hp of bridge motor and rating	25		20	
3. Computed running hp required	8.85		8.75	
4. Service factor used	2.83		2.29	
5. Girder section at center of span	Top 28 x ¾ in. Bottom 28 x ½ in. Webs 60 x ¼ in.		Top 28 x 5/8 in. Bottom 28 x 3/8 in. Webs 54 x 5/16 in.	
6. Number and diameter of bridge wheels	4 - 24 in.		4 - 21 in.	
7. Maximum wheel load, lb	50,600		44,000	
8. Wheel base	13 ft 8 in.		12 ft 3 in.	
ELECTRICAL:				
Control —				
Make and type of hoist control	Semi-magnetic drum		Drum control	
Make and type of auxiliary hoist control	Semi-magnetic drum		Drum control	
Make and type of hoist limit switches	Motor circuit		Control circuit	
Make and type of trolley control	Drum		Drum	
Make and type of bridge control	Drum		Drum	
Make and type of overload protection	Overload relays		Fuses	

In Item 7 under Hoists, we find that bidder "A" has specified a welded steel drum for the main hoist and a cast iron drum for the auxiliary hoist. Bidder "B" has indicated that a cast iron drum is supplied for both the main and auxiliary hoist. Certainly, the welded steel drum that bidder "A" has specified is clearly a better mechanical unit than the cast iron drum specified by bidder "B." This is because of the solid steel plate material under the rope grooves, requiring less material under these grooves than is normally required on a cast iron drum, providing a lighter weight drum and certainly a stronger drum.

For Item 8, we note that both bidders have specified roller bearings on the hoist gear train.

On Item 9, we find that both bidders have specified spur gears of welded steel and forged steel pinions.

However, under Item 10, we note that the material of the gears and pinions under bidder "A" is SAE-8630 for the gears and for the pinions SAE-8742. This is a nickel alloy steel and, with heat treatment as specified, provides a tough, hard-wearing surface and a long-wearing gear. Bidder "B" has stated that he uses SAE-1040 for the gears and SAE-1045 for the pinions. This is a high carbon steel and is a good gear, but does not compare in quality with the nickel alloy steel gear provided for by bidder "A."

Now, let us analyze the trolley under the bid tabulation. For the trolley speed, bidder "A" has specified 200 fpm. We believe this is more in line for a 90-ft span crane than the 125 fpm specified by bidder "B." Bidder "A's" trolley would travel across the bridge in approximately 27 seconds, whereas in the case of bidder "B," it would take the trolley approximately 43 seconds to travel the full 90 ft. Take out your watch and see how long 43 seconds are. Certainly, you will then agree that in modern times, and with modern material handling methods, it takes entirely too long for the trolley to travel that distance.

Analyzing Items 2, 3, and 4 together, we find that bidder "A" has a 7½-hp motor, naturally this must be larger because of the higher trolley speed. However, we find that the computed running horsepower is 3.5 and he has a service factor of 2.14, compared to the 3-hp motor for bidder "B," requiring a 1.96 running horsepower and providing a factor of only 1.52. The factor of 1.52 is entirely too small and inadequate to take care of satisfactory acceleration of the trolley motor.

Under Item 5, the diameter of the trolley wheels, we observe that bidder "A" has provided 13½-in diameter trolley wheels, in comparison with the 12-in. wheels bidder "B" is offering. This again indicates that bidder "B" has figured on a smaller trolley than bidder "A." The size of the trolley wheel with its bearings is similar to the explanation given for bridge truck wheels.

Under Item 6, the spread of the trolley for bidder "A" is 8 ft, and 7 ft for bidder "B." This is determined principally by the lift required and the amount of cable that has to be piled on the drum. One can see that 8 parts of ⅝-in. cable will take more space or winding capacity on the drum than 8 parts of ⅜-in. cable.

Under Item 7, both bidders have specified roller bearings.

Item 8, both bidders have specified welded spur gears and forged steel pinions.

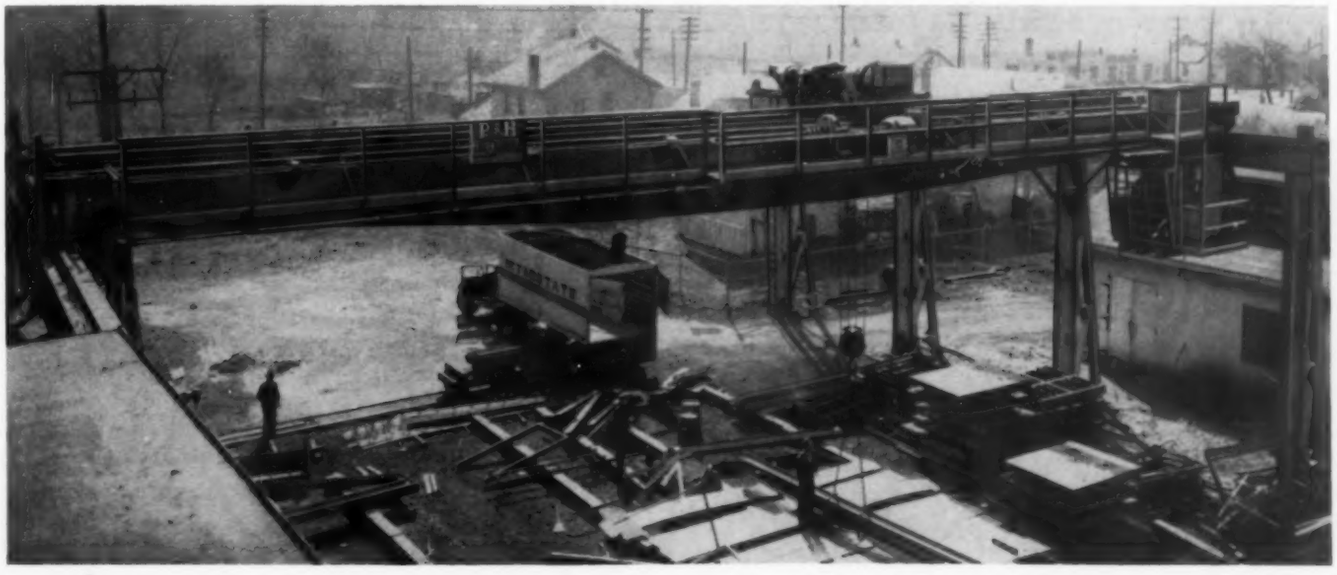
Under Item 9, material of gears and pinions, bidder "A" has specified the same type of gearing that is on the hoist gear train, a nickel alloy steel SAE-8630 and SAE-8742, against bidder "B's" SAE-1040 and SAE-1045, a high carbon steel.

The weight of the complete trolley indicates that bidder "A" has a heavier trolley, 18,400 lb against 13,000 lb for bidder "B."

In summation, looking at the trolley, it is very evident that bidder "A" has provided a larger trolley pattern based upon 30 rope diameters for the hoisting drum, and has a larger factor of safety in the hoisting cables than bidder "B." He also has provided a higher trolley speed and, therefore, the crane will be relatively faster in taking care of the material to be handled.

Now, let us make a similar analysis of the crane bridge. We notice that under the bridge specifications

Figure 4 — This "Class 3" crane is typical of similar installations in light foundry and mill service operations.



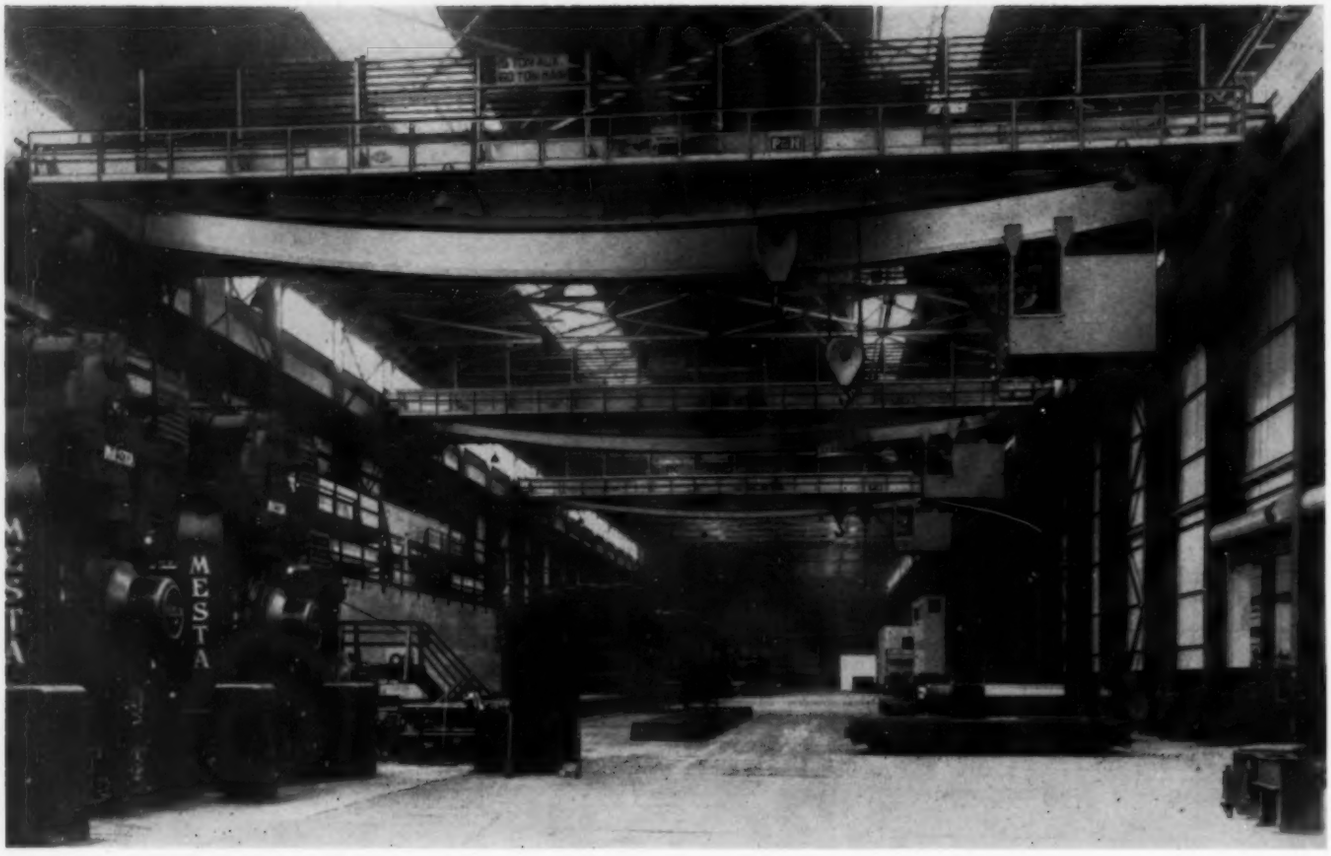


Figure 5 — "Class 4" cranes cover equipment for constant duty, where heavy foundry, production line work, and hot metal movement are required.

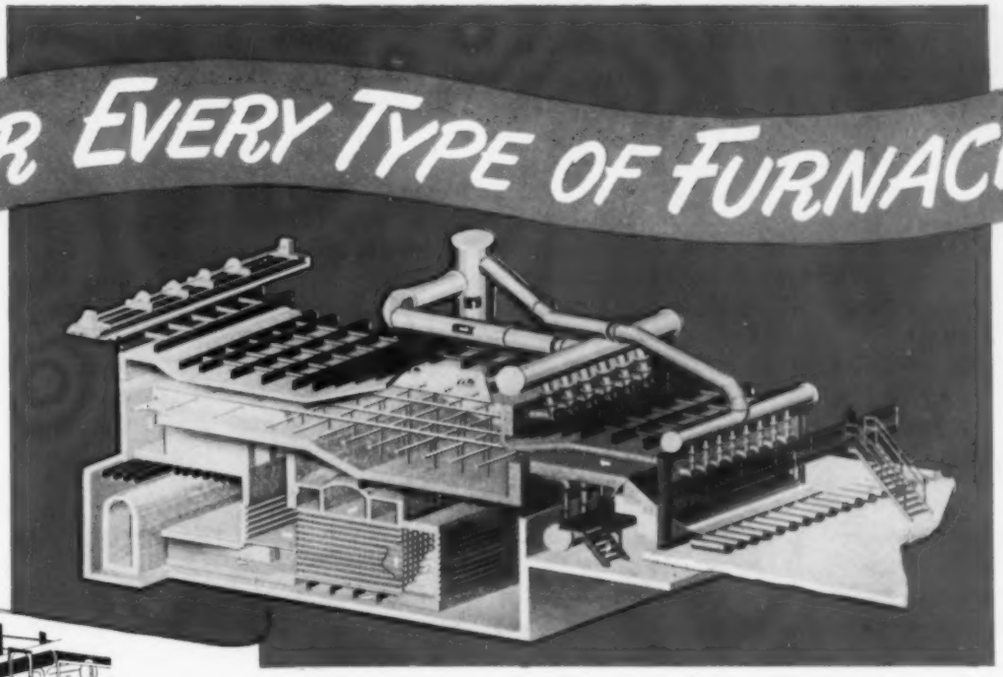
the bridge speed for both bidders is 300 fpm. As to the horsepower of the bridge motor, here again we should take Items 2, 3, and 4 together, and we find that bidder "A" has provided a 25-hp motor and he has computed the running horsepower at 8.85, providing a service factor of 2.83. Bidder "B," with a 20-hp motor, has a computed running horsepower of 8.75 and a service factor of only 2.29. Here again, we believe that the higher bridge motor factor used by bidder "A" is definitely an advantage.

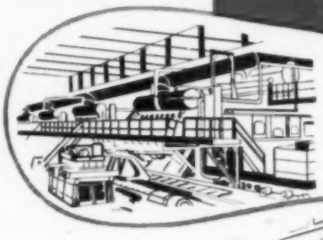
Under Item 5, we find tabulated the girder section at the center of span. Bidder "A" has provided web plates of 60 in. in depth by ¼-in. plates, and has cover plates 28 in. × 34 in. for the top and 28 in. × ½ in. on the bottom. Bidder "B" has provided 54 in. deep web plates 5/16 in. thick. The cover plates are 28 in. × 5/8 in. and 28 in. × 3/8 in. Without much question, I believe it is readily apparent that the thicker cover plates for bidder "A" definitely gives him an advantage in that respect. However, as a rule-of-thumb to determine the minimum depth of web plates at the center of span, it should not be less than 1/18 of the span. One-eighteenth of the span involved requires a 60-in. minimum web plate. Therefore, bidder "A," although he has thinner web plates, has provided sufficient depth to the girder, and although bidder "B" may have just as strong a girder because of the 5/16-in. thickness of web plates, he has provided more dead weight in the girder than is necessary. This dead weight does not add any strength. His depth at the center of span is less than 1/18 rule-of-thumb requirement.

Under Item 6, we find that bidder "A" has provided four 24-in. truck wheels against bidder "B's" four 21-in. truck wheels. Here we must rely upon the data given above, which indicate that a 24-in. truck wheel will have more service life and greater bearing life hours built into its corresponding drive parts than the 21-in. wheels and drive parts of bidder "B." The only definite way of making a verification of these facts would be requiring the crane builder to submit the bearing life hours, either given in average bearing life hours or in the B-10 rating, which now is being widely adopted. This would give definite proof of the bridge truck bearing life expectancy.

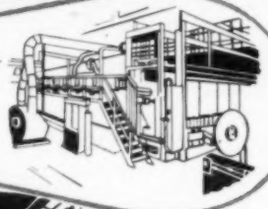
Item 7 has a very important factor on the bearing life hours of the truck wheels, and we find that bidder "A" has shown a maximum wheel load of 50,600 lb against bidder "B's" 44,000 lb. Now, maximum wheel load means just what it says. It means that the crane trolley will be at its closest approach toward the crane runway and have a 20-ton load suspended from its hook. Under normal conditions, the cage corner or the corner of the crane where the cage is suspended will have the maximum wheel load. On this corner is concentrated the weight of the cage with its control apparatus in addition to the weight of the trolley and its load. If the crane has full magnetic control mounted on the platform, this also must be included in the wheel reaction at the cage corner, since the concentrated weight of full magnetic control mounted on the platform will materially affect the maximum wheel load. Since some variation of wheel loads and their method of

FOR EVERY TYPE OF FURNACE

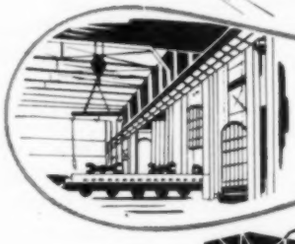




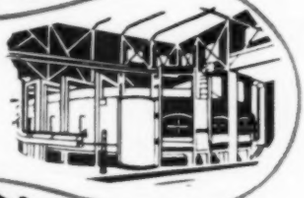
SLAB, BLOOM, BILLET, BAR HEATING FURNACES



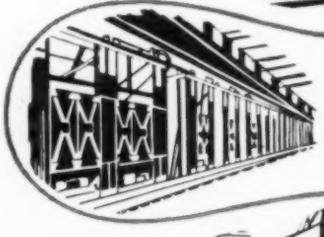
CONTINUOUS PIPE ANNEALING FURNACES



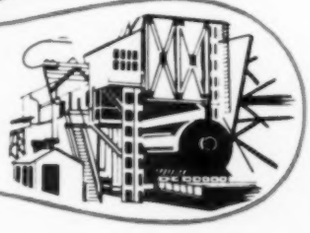
CAR BOTTOM TYPE HEAT TREATING FURNACES



ROTARY HEARTH, BLOOM AND BILLET HEATING FURNACES



BOX ANNEALING FURNACES



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F-2

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calculations are apparent from various crane builders, it is well for a buyer to use the heaviest wheel load specified in order to be on the safe side. Keep in mind that a crane is no better than the runway that supports it, and if the crane runway is designed on the basis of a low wheel load, a light runway section definitely will be detrimental to keeping the runway in good alinement. A runway that does not keep in good alinement will be the cause of constant maintenance to the crane itself.

Under Item 8 of the bridge, we note that the wheel base specified by bidder "A" is 13 ft 8 in. and that specified by bidder "B" is 12 ft 3 in. Here again we can use a rule-of-thumb that the ratio of span to wheel base shall be a minimum of 1 to 7. The 90-ft span divided by 7 gives us an approximate minimum wheel base of 12 ft 9 in., and therefore bidder "A" has exceeded this minimum requirement, and bidder "B" is somewhat under the minimum requirement. The reason for this rule-of-thumb is to provide squaring action for the crane itself. If the wheel base is too short for the span, the squaring action of the crane and its ability to run straight down the runway will be impaired greatly.

Now, summarizing the differences between bidder "A" and "B" on the bridge drive, we find that bidder "A" has met or exceeded minimum requirements and bidder "B" has not met these minimum standards. It definitely would indicate that the bridge as supplied by bidder "A" is superior to that supplied by bidder "B."

Let us now analyze the electrical equipment, making a brief comparison on the type of control apparatus specified by bidder "A" and "B." Bidder "A" indicates that the type of main hoist control is of the semi-magnetic drum type, while bidder "B" indicates drum control. Bidder "A" therefore indicates that the power circuit to the motor is made and broken by a magnetic contactor rather than the drum controller itself. This would definitely provide less maintenance, and certainly justifies a greater initial cost. The auxiliary hoist control is indicated to be the same as the main hoist. The same reasoning would favor the semi-magnetic control over plain drum control of bidder "B." The hoist limit switch is of the motor-circuit type in "A," and the control-circuit type in bid "B." This would indicate that bidder "A" has provided a limit switch which is direct acting by the bottom block, opening the motor circuits by such action; whereas, bidder "B" has a control circuit limit switch which is direct acting by the bottom block, opening the limit switch contactor coil circuit, which in turn opens the main motor circuit. Bidder "A's" motor circuit limit switch would definitely be more reliable.

The trolley control is specified as drum type by each bidder, and the type of bridge control likewise. The type of overload protection specified by bidder "A" has overload relays — bidder "B" specifies fuses. Definitely, bidder "A" has provided more and better material than "B." Overload relays are positive in action and do not require replacement of fuse links or fuses themselves. From the safety angle, the use of fuses instead of overload relays for a crane protective panel I believe are quite obvious. If an overload occurs, definitely one should trace the cause of such overload conditions and eliminate the same rather than replace the fuse for one of larger capacity. The crane overload protection panel is provided for the protection of the crane operator and the crane owner.

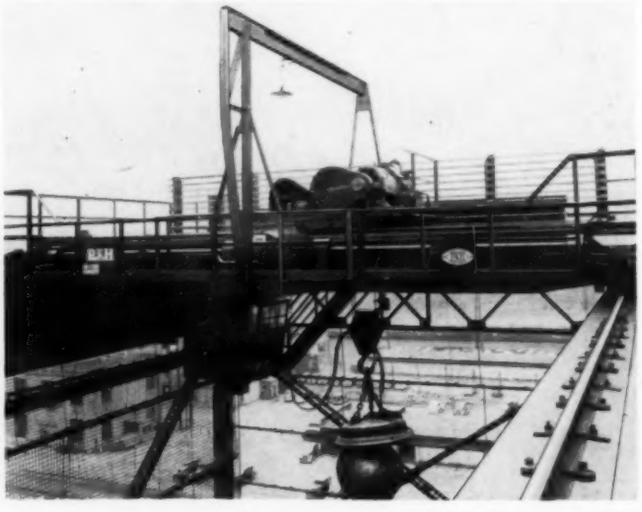
We have therefore briefly evaluated the bids as tabulated on a very condensed tabulation form. It is true that many companies demand a great deal more information in evaluating their bids than what we have provided in this condensed form, but we believe that some of the data required by these large tabulations is not of any great value.

The highlights of the tabulation again are: for the *hoist*, comparing the rope diameter to safety factor and the rope diameter to drum diameter. On the *bridge*, the size of bridge wheels determines to a great extent the bearing life hours of the truck axle, the *depth of girder* section at center should not be less than 1/18 of the span, and the *wheel base* should be a minimum of 1 to 7 ratio.

There are other items in evaluating bids which cannot be tabulated. Such items include the reputation of the bidder — does he sell on price only, does he sell through factory-trained sales engineers, or does he sell through commission paid agents? Does the crane manufacturer fabricate the entire crane in his shop, or does he sublet various parts to outside builders and only assemble the crane in his shop? Does the crane builder have sufficient machine tool capacity to line-machine and line-bore his trolley frames for accurate alinement or does he depend on weldments in assembly? Does the crane manufacturer machine his motor bases and his end trucks to obtain a square girder seat? Does he machine his main girder bearing axle block fits, or does he just use the welded structure and shim for proper alinement? These are questions which cannot be tabulated, but are vital in the purchase of an overhead traveling crane. The answers to many of these untabulated data questions might provide the answer as to why a bidder is low in price. May I again repeat "It is unwise to pay too much but it is worse to pay too little."

It is hoped that this presentation has provided the purchasers of cranes with a guide for evaluating crane bids in a brief manner without resorting to elaborate bid data sheets, plus the information necessary to eliminate the guesswork and salesmen's talk in making the decision as to which crane to buy.

Figure 6 — This "Class 5" crane is included in the severe duty series where high speeds and steady operation is the normal practice.



CURRENT AISE DISTRICT SECTION MEETINGS

BIRMINGHAM SECTION

Monday, January 29, 1951 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"New Developments in Electric Coils and Insulating Materials" by D. E. Stafford, Chief Engineer, National Electric Coil Co., Columbus, Ohio.

Thomas Jefferson Hotel, Birmingham, Ala.

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BUFFALO SECTION

Tuesday, January 9, 1951 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"Air Cleaning for Blast Furnace Turbo-Blowers" by H. J. Noles, Assistant Manager, Air Filter Division, American Air Filter Co., Louisville, Ky.

"Air Cleaning for Motor Rooms and Buildings" by T. O. Zittel, Assistant Superintendent, Electrical Department, Bethlehem Steel Co., Lackawanna, N. Y.

Sheraton Hotel, 715 Delaware Ave., Buffalo, N. Y.

▲ ▲ ▲

CHICAGO SECTION

Tuesday, January 9, 1951 — Dinner 6:15 P.M.; Meeting 7:45 P.M.

"Will Neutral Grounding Improve the Performance of an Electrical Distribution System" by R. H. Kaufmann, Industrial Power Section, Industrial Engineering Divisions, General Electric Co.

Phil Smidt's Restaurant, 1205 Calumet Ave., Hammond, Ind.

▲ ▲ ▲

CLEVELAND SECTION

Monday, January 15, 1951 at Cleveland, Ohio — Dinner 6:30 P.M.; Meeting 8:00 P.M.

Tuesday, January 16, 1951 at Youngstown, Ohio — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"Hydraulic Power Applications" by E. A. Berglund, Vice President in Charge of Sales, Hydraulic Equipment Co., Cleveland, Ohio.

Cleveland: Cleveland Engineering Society, 2136 E. 19th St., Cleveland, Ohio.

Youngstown: El Rio Club, Youngstown-Warren-Warren Road, Route 422, Youngstown, Ohio.

DETROIT SECTION

Tuesday, January 9, 1951 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"Water Supply and Industrial Wastes at the Modern Steel Mill" by Loring F. Oeming, Chief Sanitary Engineer, Water Resources Commission, State of Michigan, and Dr. Jack Cooper, DuBois-Cooper Associates, Detroit, Mich.

Rotunda Theatre, Rotunda Building, Ford Motor Co., Schaefer Road, Detroit, Mich.

▲ ▲ ▲

PHILADELPHIA SECTION

Saturday, January 6, 1951 — Dinner 6:00 P.M.; Meeting 7:00 P.M.

OLD TIMERS NIGHT

"The Electrification of the World's Largest Plate Mill" by M. B. Antrim, Superintendent of Electrical Maintenance, Lukens Steel Co., Coatesville, Pa.

Inspection of Plate Mill is scheduled for the morning.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

▲ ▲ ▲

PITTSBURGH SECTION

Monday, January 8, 1951 — Dinner 7:00 P.M; Meeting 8:00 P.M.

"Operation of a Modern Blooming Mill" by R. W. Graham, General Superintendent, Carnegie-Illinois Steel Corp., Duquesne, Pa.

University Club, University Place, Pittsburgh, Pa.

Why P&H *Job-Engineered* Cranes mean better service for you

When you buy a P&H Overhead Crane, you buy proved performance. Your crane will be *engineered* to meet the requirements of your specific job — coordinated with P&H electrical equipment, designed . . . not adapted . . . for crane service. There will be ample reserve capacity, adequate service life, maximum safety and every modern operating advantage. All these combine to give you long years of crane service with the least trouble and maintenance cost.

P&H Magnetorque* control for AC cranes brings you one of the most important improvements of the past 20 years. Ask your P&H Sales Engineers about it.

These are Added Values which P&H has learned to put into the building of overhead cranes through 65 years of progressive leadership. Perhaps that explains the overwhelming preference for P&H Cranes.

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Write for your copy of Bulletin C-39 describing P&H Magnetorque Control for AC cranes.

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THIS installation at the Madison Wire Company, Buffalo, New York, consists of one furnace and three bases. Charge size 36" diameter, 60" high. For small tonnages of fine wire.
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REPUBLIC STARTS MAJOR EXPANSION IN CLEVELAND DISTRICT

▲ Plans for the biggest single expansion of steelmaking capacity ever undertaken in the Cleveland district will add 672,000 net tons of steel ingot capacity per year to Republic's Cleveland plant. This is in addition to 180,000 tons resulting from an expansion of the present open hearth plant now nearing completion.

The expansion will represent an investment in excess of $75,000,000. It will provide employment for 800 more men with an added estimated payroll of $3,300,000 per year. Work on the project will begin at once and first steel will be poured early in 1952.

Republic's expansion program has been made possible by the fact that Congress has passed laws permitting accelerated depreciation on facilities used in the production of defense materials. Under this law industry is permitted to amortize such defense facilities for federal income tax purposes over a five-year period. This permits industry to absorb within a relatively short time the present highly inflated cost of new plants and equipment and so stimulates the expansion of productive capacity. Republic has filed an application for a certificate of necessity with the government. This step is required under the law as a basis for the granting of accelerated depreciation.

Republic, as a part of this program, is acquiring ownership of the No. 5 blast furnace and the RFC coke plant in the Cleveland district which it has been operating on a sub-lease from the Kaiser-Frazer Corp. These facilities were built and operated by Republic for the government during World War II. Kaiser-Frazer has exercised an option in its lease to purchase the facilities from the government and has resold the coke plant and blast furnace to Republic Steel.

The major facilities included in the program are:

1. A by-product coke plant consisting of 126 coke ovens, together with facilities for coal chemical products, equipped with the most modern devices for the prevention of smoke and dust.
2. A 1,400-ton blast furnace complete with necessary steam generating and blowing equipment.
3. Four 275-ton open hearth furnaces, together with buildings, cranes, ladles, etc.
4. New soaking pits, replacing and supplementing capacity of the present eight blocks to provide for the necessary reheating of ingots.
5. Improvements to the present 32-in. blooming mill to facilitate the rolling of slabs.
6. A new 72-in. tandem cold reducing mill for the production of additional cold rolled sheets.
7. Major changes and additions to provide additional heating, annealing, pickling and other processing relative to the production of sheets and strip.

BLAST FURNACE

The blast furnace will be built adjacent to the present No. 5 furnace on the east bank of the Cuyahoga River near Campbell Road. The furnace will have a 28-ft diameter hearth and will be similar to the present No. 5 furnace, currently one of the world's largest furnaces. Production per day from the furnace will approximate 1,400 tons of iron.

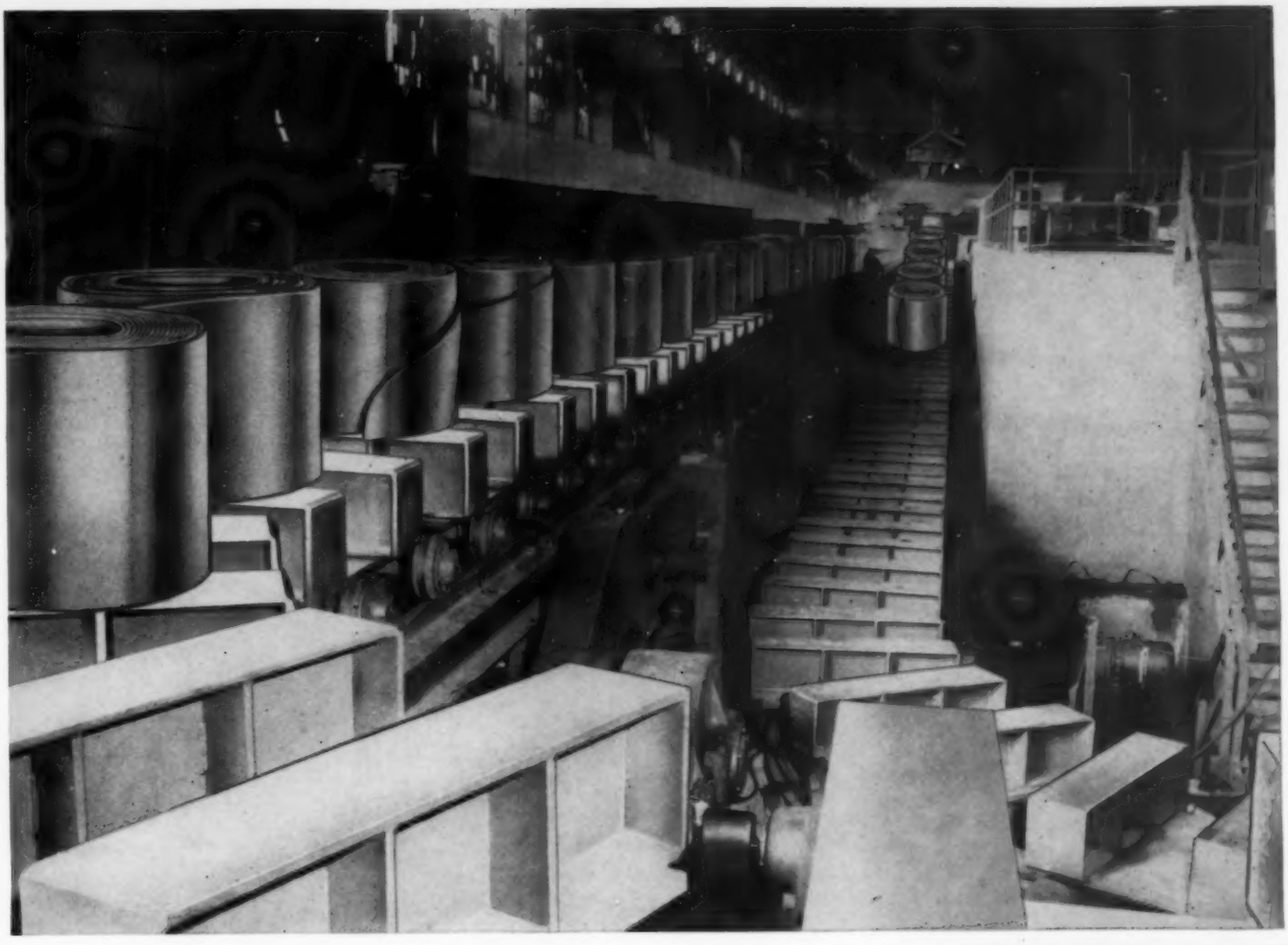
The present power house will be extended to accommodate a new boiler and auxiliary equipment to drive the turbo-blower which will provide the air blast for the furnace. The blast furnace will operate under the Republic - developed high - top pressure operation. This process permits more efficient operation of the furnace with higher iron output and less fuel consumption. It also virtually eliminates any dust or smoke from the blast furnace.

COKE PLANT

The by-product coke plant will be built south of the blast furnaces. The ovens will consist of two 63-oven batteries of the latest design and provided with every facility to prevent smoke from escaping into the atmosphere. A conveyor system will be constructed which will permit coke to be delivered from the ovens to the furnaces without loading into railroad cars. A coal chemical products plant and storage tanks will be erected west of the coke ovens to recover and store coal chemicals made from the coke oven gas. The contract to build these ovens has been awarded to the Koppers Co., Inc., at a cost of over $30,000,000.

OPEN HEARTH FURNACES

The four new open hearth furnaces will be erected in a new building west of the present open hearth building which parallels Independence Road north of the Clark Avenue Bridge. The furnaces will be built by Freyn Engineering, Co., a subsidiary of Koppers, Inc. Two charging machines and six cranes ranging from 15 to 400 tons carrying capacity will be contained in the new structure. Eleven hundred feet of trestle and a substantial amount of railroad track will be laid to service the new open hearth furnaces. Two 100-ton diesel locomotives will be required to supplement the present transportation system together with a number of specially designed cars. The diesel engines are being purchased to eliminate the smoke from steam locomotives.



For numerous turns, for best use of limited space, for cooling hot coils on end... USE THIS

Car-Type Conveyors consist of a series of heavy cars, each equipped with a pair of cross beams at the top and spaced to carry one coil on end. Cars are connected by a single roller chain. Cars can travel around corners and up and down inclines. Coil remains on own car from loading to unloading without transfer. Where cooling space is limited, conveyor can continue in adjacent runs in opposite directions.

We invite you to discuss your conveyor problems with a Link-Belt Engineer who has experience in increasing yield through coil conveying and handling.

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LINK-BELT WIDE PALLET CONVEYOR

LINK-BELT CAR-TYPE CONVEYOR

LINK-BELT LOAD-UNLOAD TILT-TURN AND AUXILIARY DEVICES

LINK-BELT COIL CONVEYORS

"THE HIGHWAY TO GREATER YIELD"

Figure 1 — Shown in white are the new structures to be added to the 98-in. hot and cold strip mills.

Figure 2 — On the right of this aerial view of the steel plant has been sketched the location of the new open hearth furnaces authorized.

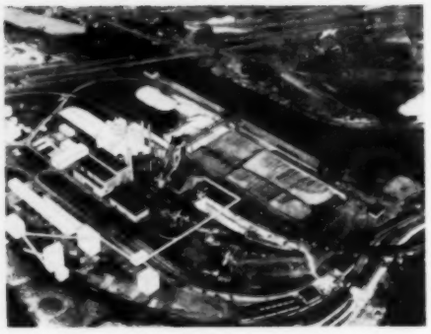

Figure 3 — The new blast furnace is shown adjacent to the existing No. 5 furnace and indicated also are coke plant and auxiliary facilities.

SOAKING PITS

For the reheating of ingots preparatory to rolling, there will be constructed seven blocks of 3-hole pits of a type of combustion which will greatly reduce the dirt from this operation. These will replace the existing seven blocks of pits and will provide sufficient capacity to reheat for rolling all ingots presently produced plus those added by the new steel making furnaces. A new crane and handling devices will be installed for conveying the reheated ingots to the blooming mills.

BLOOMING MILLS

At the present time, Republic operates two blooming mills in the Cleveland district. The large 44-in. mill converts ingots into slabs for subsequent processing into sheet and strip. The second mill, a 32-in. mill, has been used primarily for rolling sections known as blooms for processing into billets and bars. The 32-in. mill will be converted to facilitate rolling slabs as well as blooms.

STRIP MILL

Republic's mills for producing sheet and strip steel from slabs are located on the east bank of the Cuyahoga River north of Harvard Avenue. The 98-in. continuous hot strip mill is the largest and fastest mill of its kind in the world. Under the program, a large number of changes and additions will be made to increase output from this mill.

The slab storage yard will be extended 300 ft with an addition to the building. The three slab-heating furnaces will be rebuilt and enlarged. A fourth slab-heating furnace is now being constructed under a previous program.

To handle the increased steel coming off the hot mill, a new coiler and coil conveyor will be added, supplementing the present two coilers. A 48-in. continuous pickling line will be erected in a new building parallel to the present structure which houses two 98-in. continuous pickling lines. A new coil conveyor will be installed from the picklers to the cold rolling mills. To cold reduce the additional steel tonnage, a 72-in. four-stand tandem mill will be erected in the present roll shop area. The roll grinding equipment will be moved to a new building 80 x 370 ft which will be built south of the present continuous pickling building. To provide additional annealing capacity for the increased production, ten radiant tube annealing furnaces will be installed in a new 105 x 600 ft annealing building.

Finally, a new finishing and shipping building will be constructed to the west of the present buildings on land bordering the Cuyahoga River. It will be necessary to relocate a portion of the river near the Harvard-Denison viaduct.

PRESENT FACILITIES OF REPUBLIC STEEL

Republic Steel Corp., in its Cleveland district plant, is currently operating five blast furnaces, 15 open hearth furnaces and five batteries of coke ovens totaling 279 ovens.

The daily capacity of the five blast furnaces is 4,615 tons. Addition of the sixth furnace will boost this daily capacity to over 6,000 tons. Completion of current construction and construction contemplated for the near future will enable each of the 15 open hearth furnaces to produce 220 tons per heat. This, coupled with the use of Liberian ore, is expected to increase rated annual capacity from present steel making furnaces to 1,937,000 tons. Annual capacity after completion of the program announced will be 2,609,000 net tons.

One of the five present batteries of coke ovens was constructed during World War II to provide a supply of coke for No. 5 blast furnace. The other four batteries were built during World War I. Installation of the new ovens will not only insure an adequate coke supply for the new furnace but will ultimately permit one or more of the old batteries to be retired.

Present employment at the steel plant at the 7,300 level creates an annual payroll of $29,600,000. The addition of 800 employees will increase this payroll by $3,300,000 during periods of peak employment.

To supply Republic's present Cleveland facilities requires two and one-quarter million tons of iron ore per year and the additional ore requirements will amount to about 1,000,000 additional tons of ore.

Coal requirements in the past have been 2,000,000 tons per year at peak operation. The new facilities will require 1,000,000 additional tons.

Republic Steel Corp.'s Cleveland district steel plant is already Ohio's largest open hearth steel producer. When the new capacity is added it will become the largest plant in the Republic organization, forging ahead of the Youngstown district plant which produces both open hearth and bessemer steel and now holds the No. 1 position. In addition, it will probably be the largest steel producing plant in the state regardless of production methods employed.

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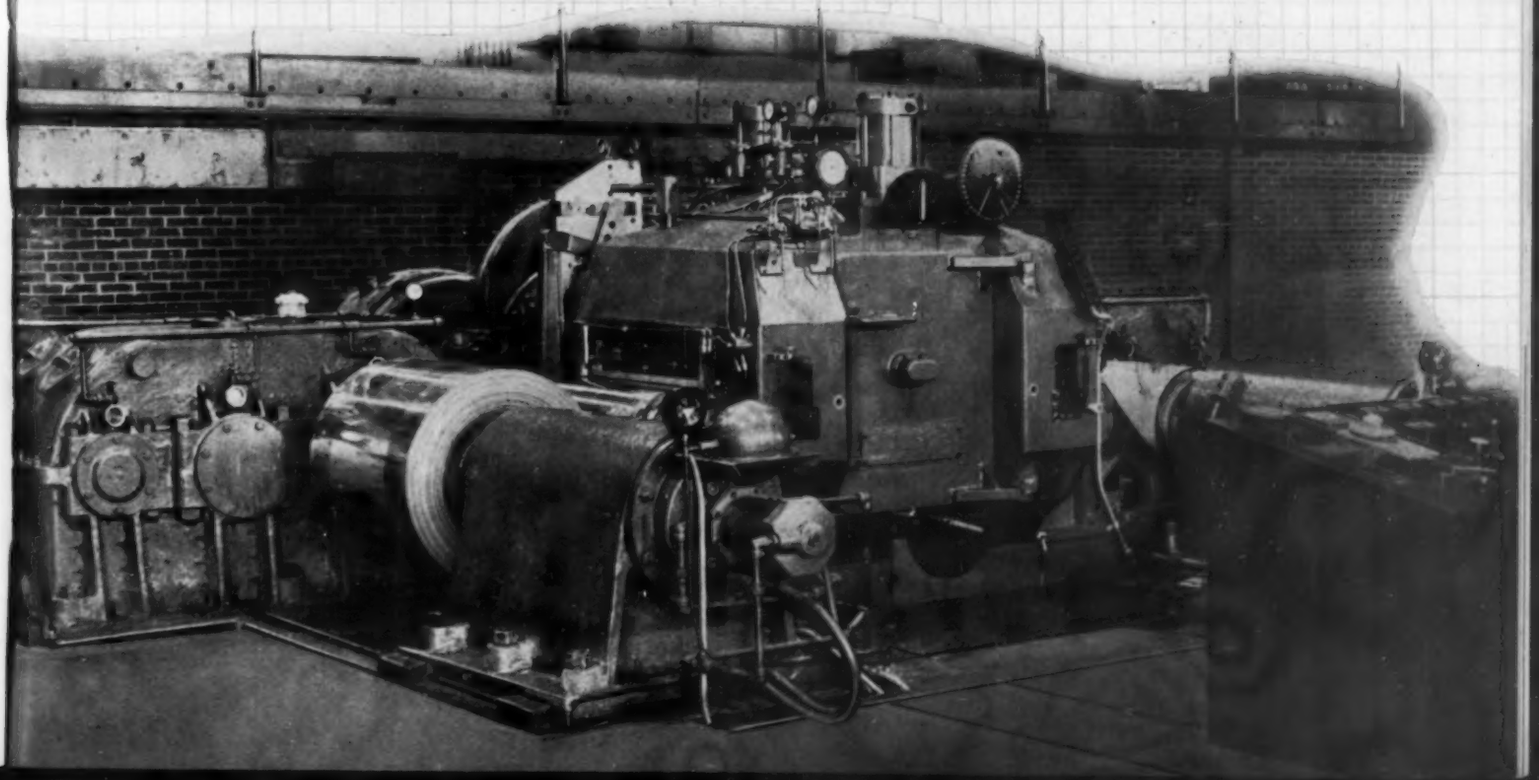

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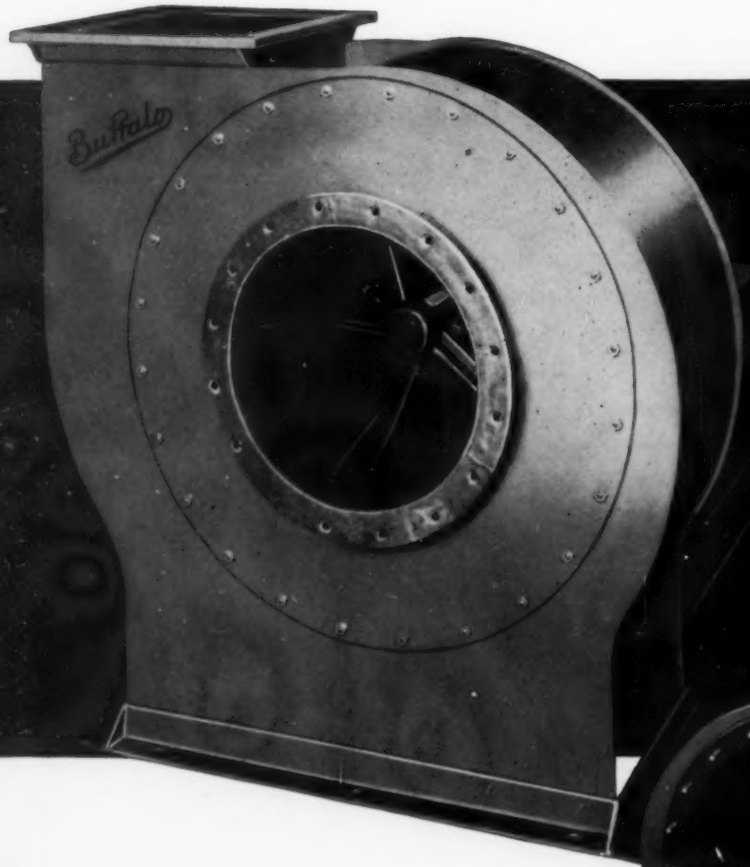

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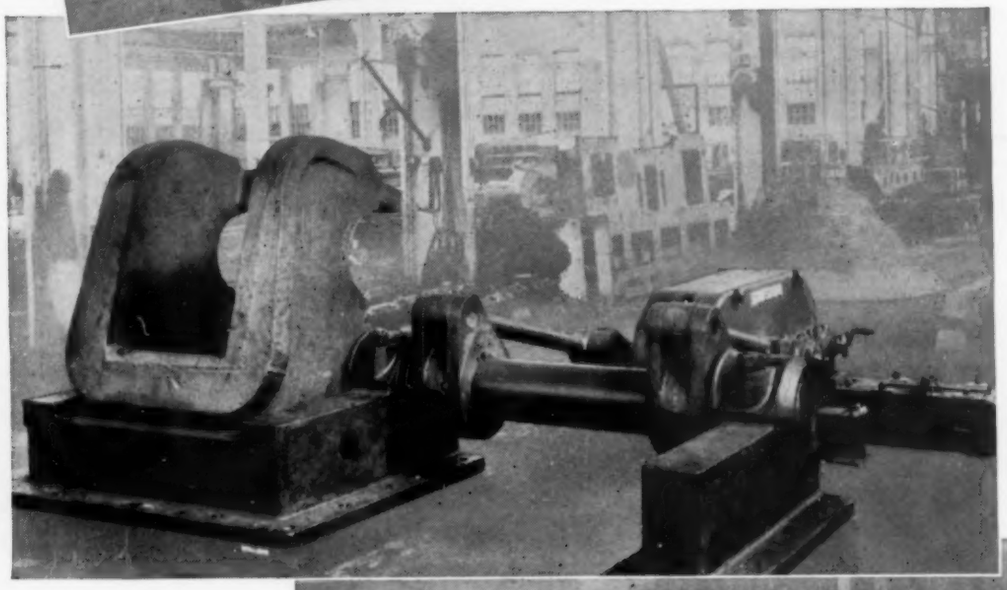

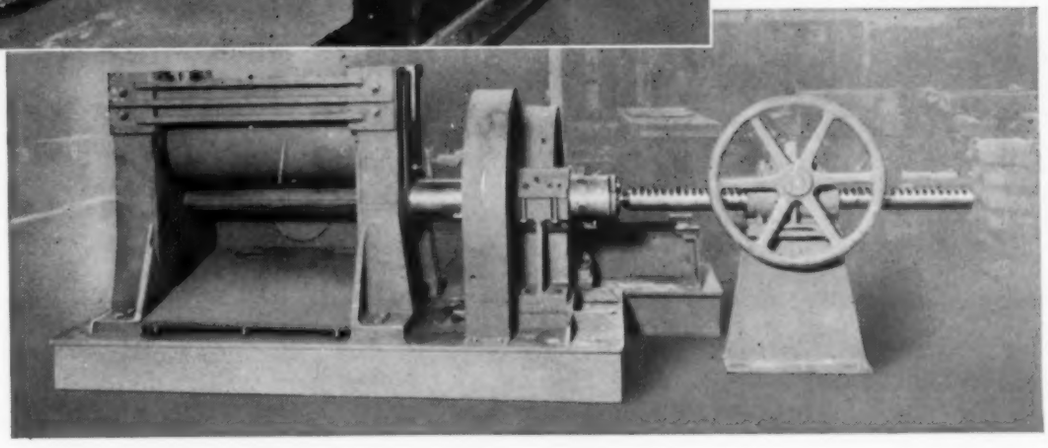

TOP—Skelp Crop Shear

MIDDLE—Ingot tilting pot for 32" Blooming Mill

BOTTOM—Cobble Coiler for Rod Mill

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Date-line Diary...

November 1

▲ The directors of the Colorado Fuel and Iron Corp. approved a $26,000,000 improvement program at Pueblo which will increase steelmaking capacity 325,000 tons annually.

November 2

▲ Engineering construction contract awards in the week ending November 2nd totaled $199,000,000 which is 13 per cent below the average week this year.

November 3

▲ Price of tin rose in New York to $1.32 a lb.

November 4

▲ Four subsidiaries of United States Steel raised mill prices of pig iron $3 per gross ton.

▲ Commerce Department reports that unemployment dropped to 1,940,000 in October, for the lowest level in almost two years. Employment rose to 61,764,000.

November 5

▲ The group of stockholders who sued Portsmouth Steel Corp. to collect a fair cash value for their stock won their case in a Common Pleas Court.

November 6

▲ American Railway Car Institute reports that orders for new cars during October totaled 21,893 leaving a backlog on November 1 of 122,488. Deliveries during October totaled 5501.

▲ According to the Bureau of Mines, marketed production of natural gas in 1949 increased 5 per cent to 5,419,736,000,000 cu ft. Total consumption in 1949 was 5,197,014,000,000 compared with 4,945,149,000,000 in 1948. Average value at well declined from 6.5¢ to 6.3¢ per 1000 cu ft.

▲ Sheffield Steel & Iron Co. awarded the Koppers Co. a contract to construct a 30-oven coke battery at a cost of about $2,000,000.

▲ The operating rate of the steel industry for the week beginning November 6th will be 103.0 per cent capacity, a new record according to the AISI. This is equivalent to 1,986,600 tons compared with 1,975,000 tons one week ago.

November 7

▲ United States Steel Corp. announced that effective January 1, it is merging four of its wholly-owned subsidiaries into a single operating company. Firms included are Carnegie-Illinois Steel Corp., H. C. Frick Coke Co., United States Coal & Coke Co. and United States Steel Corp. of Delaware.

▲ Price of tin rose 16¢ a lb to $1.52 in New York for a new record.

▲ The Gary Plant of Carnegie-Illinois Steel Corp. set a new steel production record in October of 512,424 ingot tons. No. 4 blast furnace at Gary also set a record for a single furnace at that plant with 42,713 tons of pig iron for the month. South Chicago set a new open hearth record of 354,062 tons.

November 8

▲ Acme Steel Co. declared a quarterly dividend of 50¢ or an extra of 25¢ per share, which makes the 286th consecutive dividend payment since 1801.

▲ Price of tin rose to $1.59⅜ in London.

November 9

▲ Aluminum Association reports that production of primary aluminum in the third quarter of 1950 reached the highest level since the second quarter of 1944 with 371,945,743 lb.

▲ National Steel Corp. declared a dividend of $1.00 a share which includes an extra of 25¢.

▲ Henry Kaiser told newsmen that the United States needs an additional 30,000,000 tons of steel capacity as soon as it can be built.

▲ American Cladmetals Co. report that they will install a 30-in. cold reduction mill by 1951. Mill was purchased from Jones & Laughlin's Otis Works.

▲ Price of tin rose to $1.63 and then dropped to $1.55 a lb.

▲ The NPA ordered steel plants to allot part of their output to independent warehouses.

November 10

▲ Spot tin fell to $1.38 a lb in New York.

▲ The Commerce Department reports that personal income jumped to an annual rate of $228,300,000 in September.

▲ Union Carbide & Carbon raised price of ferroalloys about 6.5 per cent.

November 12

▲ The F. W. Dodge Corp. estimates that building contracts will drop about 19 per cent in 1951 compared with 1950.

November 13

▲ Republic Steel announced that it plans a major expansion in the Cleveland District which will include one blast furnace.

▲ Based on reports of companies having 94 per cent of steel capacity, the operating rate of the steel industry is scheduled at 102.7 per cent of capacity for the week beginning November 13th. This is equivalent to 1,980,800 tons of steel compared with 1,986,600 tons one week ago.

November 14

▲ NPA issued regulation which limits manufacturers of aluminum products to 65 per cent of what they consumed in the first half of 1950.

▲ The Allied High Commission for Germany agreed on a program which will allow Western Germany to exceed its present steel production limit of 11,200,000 tons a year. Added production must be reported to the West.

▲ F. W. Dodge announced that construction contracts awarded in the 37 states east of the Rockies totaled $1,135,815,000 or 12 per cent less than September.

▲ Carnegie-Illinois Steel Corp. put into production Carrie No. 4 furnace at Rankin which has been down for relining since June 22nd.

November 15

▲ Wheeling Steel is putting into production its No. 4 blast furnace at South Works. This will be the third furnace put into production of the three in the old Mingo Works.

▲ Truman urged quick passage of an excess profits bill.

November 16

▲ Benjamin F. Fairless, president of United States Steel Corp., stated that a fifth round of wage increases will result in increased steel prices.

▲ Jones & Laughlin plans to expand tin plate capacity in the Pittsburgh District about 60 per cent. Jones & Laughlin also started work at Negaunee, Mich. on what is expected to be the largest underground iron ore mine in the world. Maximum production will be about 1,000,000 tons a year.

▲ The New England Steel Development Corp. has decided to request government financing of its proposed mill at New London, Conn.

▲ An additional $2,200,000 has been alloted to the Findsider Steel Plant at Cornigliana, Italy for a cold strip mill. Funds come from Marshall plan money.

▲ George M. Humphrey, president of M. A. Hanna Co. stated that the financing program for developing the Labrador-Quebec deposits has been completed.

▲ Secretary Snyder asked Congress to impose a 75 per cent excise profits tax on corporate earnings.

▲ The NPA alloted 10,000 tons of steel per month in the first quarter of 1951 for construction of 12 Great Lakes ore vessels.

November 17

▲ Truman stated that wage-price controls are not needed now.

▲ Allegheny Ludlum Steel Corp. declared a fourth quarter dividend of $1.12½ a share on the cumulative preferred stock. A dividend of $1.00 was declared on the common which includes an extra of 50¢ a share.

▲ Sharon Steel relit its No. 2 blast furnace at Farrell, Pa.

November 18

▲ Copperweld Steel Co. announced that it will spend $1,000,000 to improve the steel plant at Warren, Ohio.

November 19

▲ The AISC reports that fabricated structural steel bookings in October totaled 233,922 tons. Shipments were 167,693 tons. Backlog for the next four months is 746,878 tons.

▲ Timken Roller Bearing Co. signed a wage agreement with the CIO which provides a 10 per cent increase.

November 20

▲ Based on reports of companies having 94 per cent of the steel capacity, the operating rate for the week beginning November 20 is scheduled at 102.7 per cent of capacity. This is equivalent to 1,980,800 tons which is the same as last week.

▲ Inland Steel Co. reported that the zinc shortage has required cutting back production of galvanized sheets.

November 21

▲ Commerce Department reports that maximum production of all goods and services ran at a record annual rate of $284,000,000,000 in the third quarter of this year.

▲ Six government owned magnesium plants will go into production which will increase output 400 per cent of 240,000,000 lb annually.

▲ The ICC announced a reshuffling of railroad freight rates which is expected will help some of the smaller automobile manufacturers.

November 22

▲ Carnegie-Illinois Steel established a new method of pricing tin mill products which also includes an average increase of about 12 per cent.

November 25

▲ Automobile and truck production in the week ending today fell to 113,802 units.

▲ The Equitable Gas Co. of Pittsburgh and the East Ohio Gas Co. of Cleveland have asked large industrial users to reduce consumption of natural gas.

November 26

▲ The Granite Steel Co. is considering a $50,000,000 expansion program which will double productive capacity.

▲ Steel production in the Pittsburgh and Cleveland areas was cut back markedly by a record snow storm which hit the region.

November 27

▲ The AISI could make no estimate on steel production because of the effects of the recent blizzard. Actual operations were about 81.7 per cent.

▲ The Jones & Laughlin Steel Corp. was the first company to get government approval of accelerated depreciation in its new steelmaking facilities which will cost about $144,000,000.

▲ ARMCO Steel Corp. declared a special year end dividend of $1.12½ a common share as well as the regular dividend of $1.12½ a share.

November 29

▲ Kaiser Steel announced that it will begin research for its new tin plate plant at Fontana, early next year. Operations will start in about 18 months and the mill will have an initial annual capacity of 200,000 tons of tin plate.

▲ The NPA ordered a 15 per cent slash effective January 1 in the non-military use of copper.

▲ The Aluminum Co. of America agreed to expand its facilities enough to produce 240,000,000 lb of aluminum a year. This phase will come from permanent new capacity. In addition the Aluminum Co. will expand capacity 158,000,000 lb a year through the use of existing standby facilities which requires higher cost electrical power than ordinarily is economical.

November 30

▲ Benjamin F. Fairless, president of United States Steel, announced that an agreement had been made with the United Steel Workers of America effective December 1, which raises wages about 11 per cent. Wage increases range from 12½¢ to 28¢ an hour, and average 16¢. Prices of many steel products were also raised an average of $5.50 a ton. The Bethlehem Steel Co. also announced a similar wage agreement. Jones & Laughlin Steel Corp. signed a similar agreement with the CIO, and also announced increases for salaried employees. Most of the other companies are expected to sign similar agreements. The Weirton Steel Co. signed an agreement with the Weirton Independent Union which average 15½¢, which gives that company's employees an average of $1.99½ an hour compared with the industry average of $1.88 an hour.

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Armco Steel Corporation
Bethlehem Steel Company
Carnegie-Illinois Steel Corp.
Cleveland Wire Works (G.E.)
Consolidated Vultee Airc. Corp.
Continental Steel Company
Copperweld Steel Company
Crown Cork & Seal Company
Empire Steel Corporation
Follansbee Steel Company
Jones & Laughlin Steel Corp.
Hofmann Industries
Mercer Tube Company
Mesta Machine Company
National Tube Company
Niles Rolling Mill
Parkersburg Steel Company
Reeves Steel & Mfg. Co.
Revere Copper & Brass, Inc.
Rochester Can Company
Sharon Steel Corporation
Superior Sheet Steel Co.
Tennessee Coal, Iron & R.R. Co.
Valley Manufacturing Company
Vilsack Fisher Mfg. Co.
Wheeling Steel Corporation
Wickwire-Spencer (C.F.&I.)
Youngstown Sheet & Tube Co.

*CANADA:
Dominion Foundries & Steel Co.

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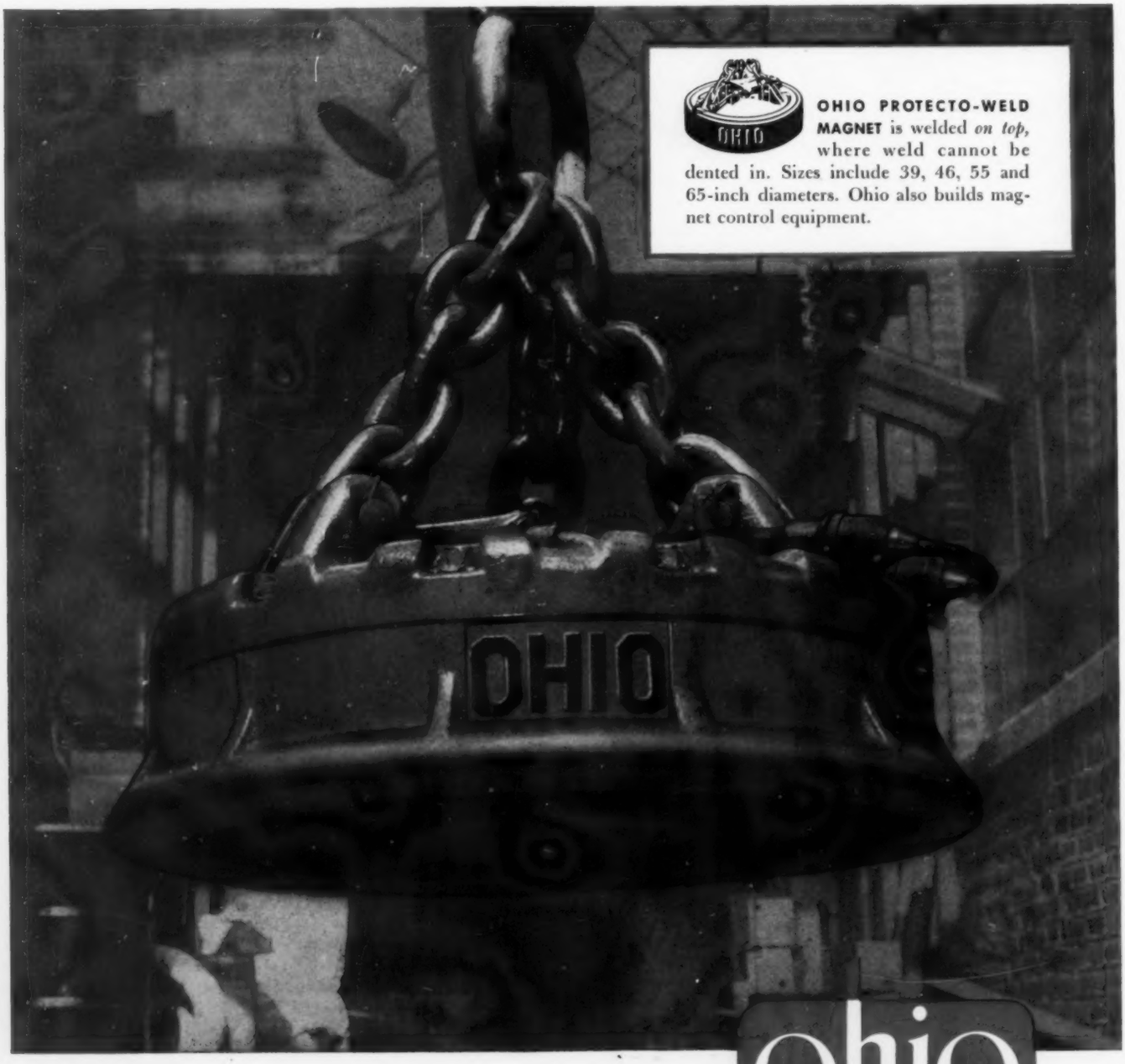

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Industry News...

GRANITE CITY STEEL IS CONSIDERING $50,000,000 EXPANSION PROGRAM

▲ A $50,000,000 expansion program which will double its productive capacity is under consideration by Granite City Steel Co., St. Louis, Mo., according to an announcement made by John N. Marshall, president and chairman of the board of directors.

Mr. Marshall said that his company has engaged the engineering and research firm of Coverdale and Colpitts, New York City, to survey and report on the feasibility of a contemplated expansion to more adequately meet the steel requirements of St. Louis and the southwest.

"It has been evident for some time to the management of Granite City Steel Co.," Mr. Marshall said, "that in spite of its recent increases in output, still more capacity is required to take care of the present and potential demands for steel in this area.

"With that situation in view, our company is prepared to act."

Two years ago, Granite City Steel completed a $26,000,000 expansion and modernization, and it is currently engaged in a $6,000,000 program which will be completed in 1951. As a result, its output has been increased from 35,000 to 60,000 tons of ingots per month.

The new program is expected to raise production to more than 100,000 tons of ingots per month, or considerably more than 1,000,000 tons annually. Last year, the company's production totalled a record 532,000 tons.

Mr. Marshall said that the company's own research and plans, which have been underway for the past 18 months, indicate that the cost of the expansion contemplated will approximate $50,000,000.

At the present time, the plans include the establishment of extensive dock facilities at the new Granite City harbor on the Mississippi River Chain of Rocks canal under the jurisdiction of the Bi-State Authority of Missouri and Illinois; the control of blast furnace facilities; addition of coke ovens; and the construction of additional open hearth facilities, blooming mill, soaking pits, slab furnaces, scarfing dock, and all the necessary complementary equipment.

SMOKE CONTROL UNITS RECOVER IRON ORE

▲ Smokeless smoke stacks are generally a sign of poor times. But at McKeesport, Pa., business is booming and new improvements are in evidence at every hand, including the five new smokeless stacks at National works of U. S. Steel's National Tube Co.

A major step toward smoke control is the installation of two modern gas washers and a companion set-up of electrostatic precipitators for cleaning gas from the blast furnaces, for use in the mill's new high-pressure boiler plant.

A second anti-smoke development at the plant, one of the nation's largest producers of steel pipe, is the installation of dust collectors that virtually eliminates the fly ash coming from the boiler stacks when coal is used for fuel instead of the blast furnace gas. The coal is pulverized to a powder and the small amount of remaining fly ash is trapped in a system of filters located between the boiler furnaces and the stacks.

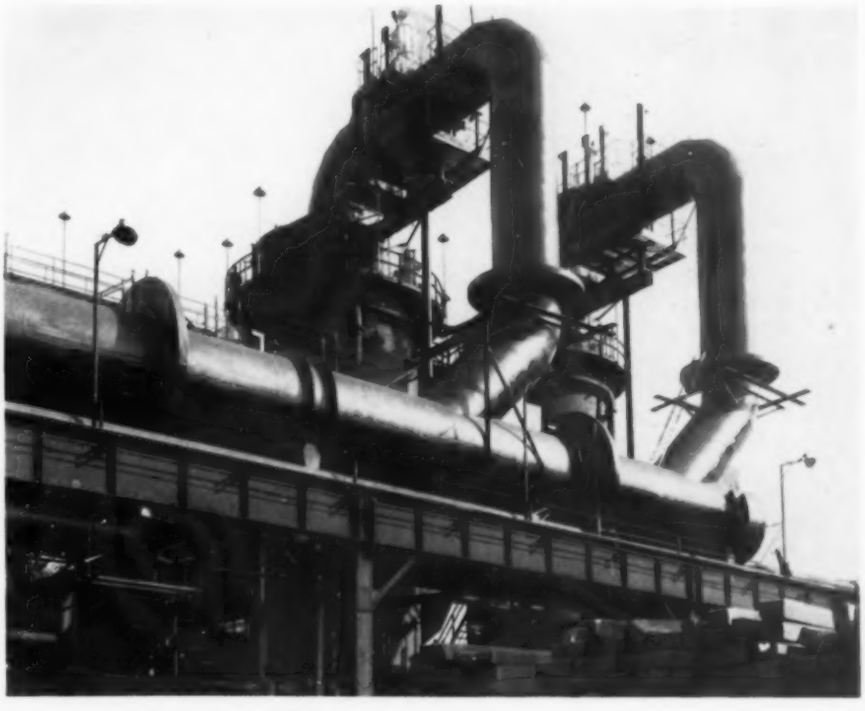
Gas from the plant's four towering blast furnaces is now thoroughly cleaned in a two-stage system, first through the gas washers, then in the precipitators. The gas is the principal fuel for the five new boilers, each of which will be capable of furnishing 175,000 lb of steam per hour, when the project is finished.

The gas cleaning system installed at the big pipemaking plant reduces the dust content of the gas entering the boilers to about one-hundredth gram per cubic foot—cleaner than the surrounding, outside air.

Inside the washers, the gas is cleaned by a multiple battery of water sprays, which wash out minute particles of iron dust.

The dust recovered from the furnace gas is collected as sludge in a 90-ft circular thickening tank. The minute iron-bearing particles are then "caked" and reused in the blast furnaces. In this operation, the plant is

Gas washers installed at the National works of National Tube Co. are expected to recover 100 tons of iron ore every 24 hours.



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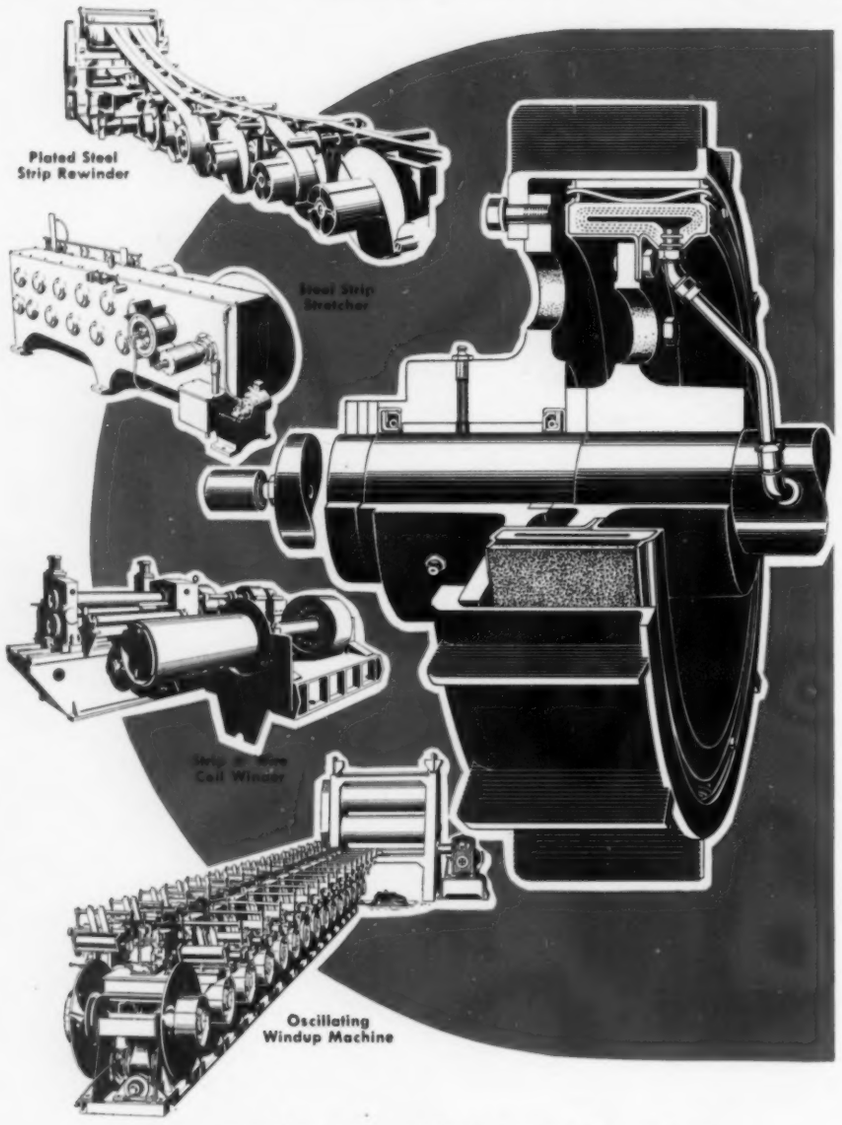

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All desirable clutch characteristics are built into Fawick Airflex units

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5919 CLINTON ROAD CLEVELAND 11, OHIO

FAWICK CLUTCHES = + + + = PEAK EFFICIENCY
AXIAL CONTACT 360° RADIAL CONTACT SHOCK ABSORPTION CONTROLLED TORQUE

expected to recover some 100 tons of iron ore every 24 hours.

The seven-story-high new boiler plant, which will supply steam for all operations at the U. S. Steel pipe mill, is another major project in the corporation's multi-million dollar building program in mines and plants extending from coast to coast. The five new boilers are replacing 57 old low-pressure boilers, all in service more than 40 years.

J & L EXPANDS TIN PLATE PRODUCTION AT ALIQUIPPA

▲ The expansion of Jones & Laughlin Steel Corp., tin plate production at Aliquippa, Pa., works has been announced. The company's annual production of tin mill products now averages around 325,000 tons. The electrolytic tinning capacity at Aliquippa will be doubled. J & L's tin plate capacity will be increased by 60 per cent. Plans call for installation of a high-speed electrolytic line for coating the steel with tin, as well as constructing a two-stand temper mill, an electro cleaning line and additional annealing and coil preparation equipment.

"Y"-MILL PURCHASED BY FRENCH STEEL MILL

▲ Mackintosh-Hemphill Co., Pittsburgh, Pa., has sold a 20-in., "Y" type, reversing cold strip mill to S. A. Etirage et Laminage du Nord for installation in Jeumont (Nord), France.

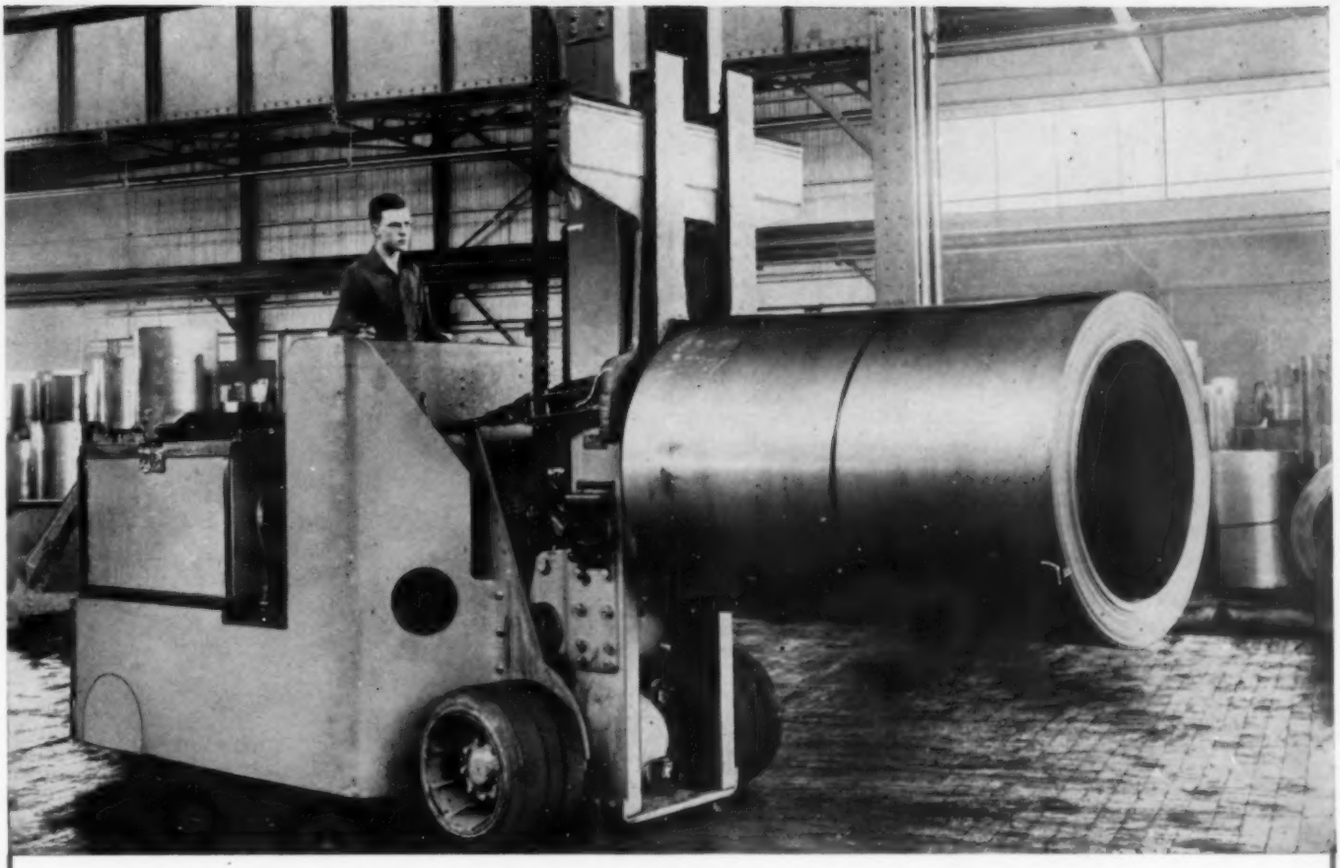
This new Mackintosh-Hemphill mill, soon to be installed by "Etilam," will cold roll and coil up to 16 in. widths of low carbon, high carbon and alloy steels. It will work on .125 in. thick hot rolled strip and roll it down to .010 in. or less.

This is the first "Y" type reversing cold strip mill to be installed in France.

INLAND STEEL CO. HAS RECORD SHIPMENTS

▲ Inland Steel Co. set a new high in steel shipments for the month of October, Hjalmar W. Johnson, vice president in charge of steel production, announced recently.

Shipments from its Indiana Harbor works at East Chicago, Ind., for



You get FULL SHIFT trucking operations with

EXIDE-IRONCLAD BATTERY POWER

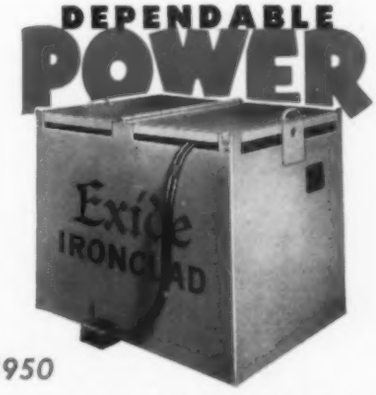
You can count on uniform performance throughout each shift when your battery electric trucks are powered by Exide-Ironclads. Your trucks will handle as much load during the last hour as during the first . . . with practically no difference in speed . . . with no unscheduled periods of down time.

Exide-Ironclad Batteries deliver power instantly to meet all demands—light or heavy —in *start-stop*, *lift-and-shift* manipulations. They assure you finger-tip control, accurate spotting, easy maneuvering, safe handling. You also benefit from the savings that Exide-Ironclad Batteries provide—low operating costs, low maintenance costs, an exceptionally long life . . . proved in more than 100,000 heavy-duty jobs.

The combination of these superior characteristics make Exide-Ironclad Batteries your best power buy . . . *at any price.*

Write for more facts and FREE copy of Exide-Ironclad Topics. It contains latest developments in materials handling . . . shows actual case histories.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto



1888...DEPENDABLE BATTERIES FOR 62 YEARS...1950

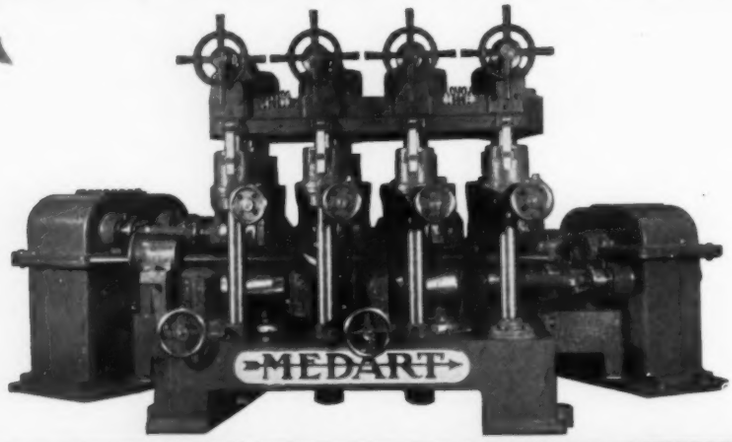
"Exide-Ironclad" *Reg. Trade-mark U. S. Pat. Off.*

MEDART MULTICYCLE
PIPE AND TUBE STRAIGHTENING MACHINE

"6 in 1"
SIX POINTS OF SUPERIORITY IN ONE

1. MULTICYCLE STRAIGHTENING—Two bending rolls impose duplex straightening cycles on workpiece insuring end to end straightness.
2. POSITIVE AND SYNCHRONIZED FEED—All four feed rolls are driven insuring positive synchronized feed and torque balanced around neutral axis of workpiece.
3. THE WORKPIECE LEVEL—Maintains one feeding level for all sizes of pipes or tubes—eliminates need of adjustable entry and delivery tables.
4. NO GUIDES—Horizontal position of the six rolls with balanced torque eliminates requirement for guides.
5. SINGLE MOTOR—All four driven rolls powered from a single motor, for synchronization and economy.
6. NO BEVEL GEARS—All gears enclosed in cases and running in oil, for sure trouble free operation.

"Patents make Jobs"



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY
MEDART
THE MEDART COMPANY · 3600 DE KALB ST. · ST. LOUIS, MO.

October were 300,264 net tons, including steel supplied to Inland by customers for conversion. In breaking the 300,000 ton figure for the first time in any month, Inland exceeded by 19 per cent the highest shipment figure attained during the peak of World War II steel operations.

The October figure compared with a previous high of 298,162 tons for May, which also included conversion steel shipments. The war time peak was 252,210 tons established in March, 1945.

Defense orders are currently taking progressively larger amounts of steel produced.

U.S. STEEL MODERNIZES DUQUESNE BLAST FURNACE

▲ Iron production at Duquesne, Pa., works of Carnegie-Illinois Steel Corp. got another shot in the arm with the announcement by Robert W. Graham, general superintendent of this U. S. Steel plant, of plans for the complete rebuilding and modernization of the mill's No. 3 blast furnace, and the installation of a new turbo-blower to replace three obsolete steam engines.

The project, a major improvement in the plant's blast furnace department, will result in some increase in production through more efficient operation, although the capacity of the stack will not be enlarged to any great extent, Mr. Graham said. The furnace was built in 1896, and has produced some six million tons of iron since it was first placed in operation 54 years ago.

Third in the row of six furnaces towering along Duquesne Ave. between Camp and Center Sts., the No. 3 stack will be changed in about every particular except the silhouette familiar to passersby.

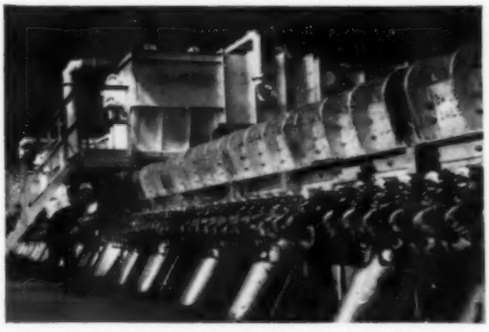
Relining of the furnace's four hot blast stoves will almost double their heating surface. The stoves will have new burners and automatic fuel burning equipment. The project includes the installation of an electrostatic precipitator to clean the gases.

The new turbo-blower will deliver 90,000 cfm to the hot blast stoves, using 50 per cent less steam than the three old engines it replaces. The 15 million gallons of cooling water required daily by its surface condenser will be returned to the plant water mains for reuse.

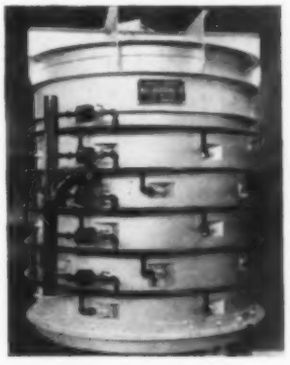
WHAT SALEM DOES IN THE METAL WORKING INDUSTRIES

Salem Rotary Hearth furnaces are used for heating steel and copper for seamless tube mills and merchant mills . . . for heating copper billets for wire mills and ingots for making wheels . . . and for annealing fish plates.

Salem Circular Pits are used for heating all types of ingots . . . fired by natural gas, coke oven gas, combinations of blast furnace and coke oven gases, and coke oven gas and oil.



All the butt-weld furnaces in the United States and Canada **have been built by Salem.**



This hood type annealing furnace, **made by Salem Engineering Company,** is used by ferrous and non-ferrous industries . . . electric or gas fired.

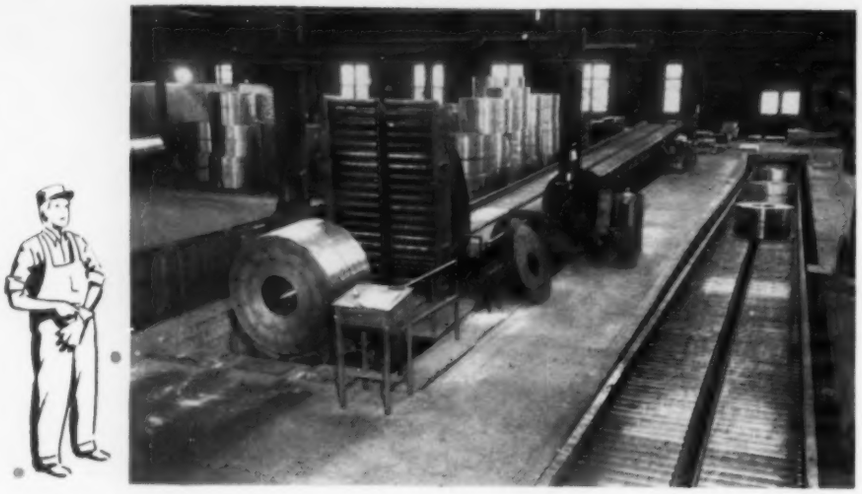
Salem Builds

CIRCULAR SOAKING PITS
ROTARY HEARTH FURNACES
CONTINUOUS BUTT-WELD FURNACES
CAR BOTTOM FURNACES
FORGE FURNACES
HEAT TREATING FURNACES
NEEDLE METALLIC RECUPERATORS
AIR RECIRCULATING FURNACES
GAS ATMOSPHERE FURNACES
MECHANICAL EQUIPMENT FOR CHARGING AND DISCHARGING MATERIAL FROM FURNACES

Steel Plant Engineers

SALEM ENGINEERING COMPANY

TORONTO, ONTARIO, CANADA — SALEM, OHIO — LONDON, ENGLAND



mechanized handling benefits everyone

● In every industry today, the advantages of mechanization are far-reaching. The production of more and better things, at less cost, which is made possible by modern production equipment, benefits employees, management, shareholders or owners, and purchasers of the product. The application of this modern equipment, and the efficiency and economy which it creates, is bringing more good things within the reach of more people.

Well-planned conveyer systems play an important part in these mechanization programs. Today Mathews Engineers are making available to American and Canadian Industry the benefit of long experience with conveying problems. This and the facilities of three modern plants are yours for the asking. Engineering offices or sales agencies are located in principal cities.

●

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
ELLWOOD CITY, PENNSYLVANIA

PACIFIC COAST DIVISION . . *Mathews Conveyer Company West Coast*
SAN CARLOS, CALIFORNIA

CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

CONTINENTAL STEEL BUYS BILLET HEATING FURNACE

▲ A single-zone pusher type billet heating furnace is being designed and built for Continental Steel Corp.'s new rod mill at Kokomo, Ind., by Salem Engineering Co.

The furnace will heat steel bars 2½ in. by 2½ in. by 30 ft long at a nominal rate of 60 tons per hour. It is equipped to burn heavy fuel oil and will be complete with Salem's needle-type metallic recuperator.

Construction is scheduled to start early in 1951.

J&L TO RAISE ITS IRON ORE PRODUCTION

▲ Jones & Laughlin Steel Corp. plans to raise its iron ore production. This will increase the concern's iron ore output by one million tons annually. It is planned to return to the Marquette iron range in Michigan for the first time since 1919. A subsidiary, Jones & Laughlin Ore Co., will begin work immediately on opening a new one million tons a year underground ore mine at Negaunee, Mich.

CONTROL FIRM NAMES PITTSBURGH AGENT

▲ The appointment of John D. Hiles Co., Inc., Pittsburgh, Pa., was announced as exclusive sales and service representatives on "Magnetrol" liquid level controls in western Pennsylvania and the sections of Ohio, Maryland and West Virginia that Hiles serves.

The "Magnetrol" line includes boiler water level controls; tank float switches in all styles and sizes; industrial liquid level controls for high pressure, high temperature applications for central power plants; as well as a wide variety of standard and special flow switches.

STEEL & WIRE PLANTS RECEIVE SAFETY AWARDS

▲ Two plants of the American Steel & Wire Co. at Cleveland, Ohio, and Trenton, N. J., have been honored by the National Safety Council for outstanding safety performances during the past two years.

The company's Central Furnaces

& Docks plant at Cleveland received two awards at a ceremony on November 14. One was a National Safety Council award for its record of 1,404,438 man-hours without lost-time accident in the 15-month period ending March 31 of this year. This performance has been maintained since then, reaching the figure of 1,875,000 man-hours on November 14.

In addition, the plant received an award from the Safety Council in recognition of its accident-free performance during the one-year period ending on June 30 of this year, giving the plant first place in a competition conducted among steel plants of this size and classification.

The award to the Trenton plant, which will be presented later, is based on its record of 1,152,503 man-hours without lost-time accident during the period of August 9, 1949, to June 30, 1950.

Like Central Furnaces, the Trenton plant has continued its accident-free performance, reaching the figure of 1,647,952 man-hours on November 1.

Central Furnaces & Docks, one of the five American Steel & Wire Co. plants in Cleveland, has 532 employes and comprises two blast furnaces, loading and unloading docks, and a slag crushing department. The Trenton works is a wire and wire rope mill, and has 787 employes.

U. S. STEEL DEVELOPS NEW STEEL PRODUCT

▲ A new steel exceptionally strong for either peace or war use has been developed by the Research Laboratory of Carnegie-Illinois Steel Corp. With good resistance to corrosion, it remains tough even at temperatures below zero where many structural materials tend to show some loss of toughness.

Bearing the grade designation "T1," this new "Carilloy" steel composition was developed for possible use in the construction of ships and heavy mobile equipment. The development was also encouraged by the manufacturers of heavy earth-moving and surface-mining machinery, for which the steel's toughness helps to prolong seasonal operations up to the time when winter cold actually freezes earth and ores.

With almost double the strength of the high-strength, low-alloy steels, "Carilloy" T1 will effect savings in mobile equipment, since the steel can be made in quantity in standard open hearth furnaces. It may be welded easily with welding electrodes that are now available; yet it possesses almost triple the strength of ordinary welding-grade structural steels. It was designed to provide at least two to three times the resistance to atmospheric corrosion offered by plain carbon steels.

Research, looking to the development of "Carilloy" T1, was begun more than four years ago. Many experimental laboratory heats were made as the development proceeded, each series of heats introducing new and valuable properties to the overall composition. Finally, following the laboratory experimentation and testing, large commercial heats were recently made.

Special attention was given to the conservation of costly and strategic alloying materials in the design of "Carilloy" T1.

EF Special Atmosphere Roller Hearth Furnace Continuously Bright Normalizing Two Strands of 27" Strip — Capacity 7200 Lbs. Per Hour.

ANNEALING STRIP STEEL *Continuously*

IMPROVES THE DRAWING QUALITIES

● EF continuous annealing and normalizing furnaces subject the entire length, and width of the strip to *exactly the same* time and temperature treatment, resulting in extreme uniformity of grain size, yield point, and completeness of recrystallization;—all definite advantages for deep drawing. They tie-up a minimum amount of material in process;—usually *cost less* than batch equipment of equivalent capacity; prevent scaling; eliminate pickling; avoid the need of "rider strips," and danger of scratching.

EF furnaces are built with capacities up to 28,000 pounds or more per hour — for handling single or multiple strands up to 54" or wider — for bright annealing, normalizing, galvanizing and other processes.

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

PROTECT METAL STRUCTURES POSITIVELY UNDER ALL CONDITIONS!

"NATIONAL" GROUND ANODES

• Regardless of what the job is . . . how corrosive the environment — whether wet or dry, hot or cold — you can depend upon "National" ground anodes to provide efficient, positive protection against underground and underwater corrosion.

"National" ground anodes have proved themselves in 20 years of successful operation in many different parts of the country. They outlast other materials by a wide margin. They do not have to be dug up and replaced every couple of years. Because they use a controllable current source, it is simple and economical to adjust their protective output to match exactly the requirements of any installation.

For complete details on "National" ground anodes, write to National Carbon Division, Union Carbide and Carbon Corporation, Dept. Z.

MORE THAN DOUBLE THE USABLE LIGHT!

The biggest news since the invention of flashlights—the brand new leakproof "Eveready" No. 1050 flashlight battery—gives more than double the usable brilliant white light for critical uses than any other flashlight battery we ever made.

NO METAL CAN TO LEAK OR CORROSE

The terms "National" and "Eveready" are registered trade-marks of

NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
Foreign Department: U. S. A.

Personnel News...

J. L. Neudoerfer has been elected president of Wheeling Steel Corp. to fill the post made vacant by the death of **Archie J. McFarland.** Mr. Neudoerfer, 63, a native of Portsmouth, Ohio, has been connected with the corporation during his entire career. He started with Whitaker-Glessner Co. in 1907 and entered the employ of Wheeling Steel when it acquired the latter company in 1920. He was elected vice president of sales in 1931 and executive vice president in August, 1949. He also is president of Wheeling Corrugating Co. and a director of the Security Trust Co., Wheeling, W. Va. Directors also elected **J. H. McElhinney** as vice president of operations.

Charles L. McGranahan, for the last 23 years employed in the continuous strip industry in America, has been appointed technical assistant to the works manager of the Sollac plants (Societe Lorraine de Laminage Continu), at Hayange (Moselle), France. Sollac is installing a steel plant, blooming mill, 80-in. continuous hot strip mill, 80-in. cold strip and a 5-stand 48-in. cold reduction mill for tin plates, together with the necessary finishing facilities. Mr. McGranahan was formerly assistant general superintendent, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Don L. Orton has been elected president of Post Electric Co., Inc., Chicago, Ill., succeeding **John E. Flanagan,** who died October 7. Mr. Orton joined the Post organization as vice president on January 1, 1950 following his resignation as vice president of the Clark Controller Co., Cleveland, Ohio.

B. C. Blake has been appointed vice president and general manager of Connors Steel Co., division of H. K. Porter Co., Inc., Birmingham, Ala. Mr. Blake succeeds **H. P. Bigler** who recently resigned because of ill health. In his new position, Mr. Blake, formerly works manager of the company, will be responsible for the complete operation of the Connors division with which he first became associated in 1929 in the structural engineering department. Mr. Blake is chairman of the Birmingham district section of the Association of Iron and Steel Engineers.

Kermit L. Johannsen has been named assistant division superintendent, maintenance, of Carnegie-Illinois Steel Corp., Duquesne, Pa. Mr. Johannsen has been superintendent (assigned and operating) maintenance at the Duquesne works since January, 1948.

J. N. Albaugh was named superintendent of the open hearth and bessemer department at Jones & Laughlin Steel Corp., Aliquippa, Pa. Mr. Albaugh was first employed by J&L as a chemist in 1917. He advanced through several positions in the open hearth department and in 1945 was made assistant superintendent of the open hearth and bessemer department, the job he held until his recent promotion.

Joseph W. Zubaly became assistant superintendent of the open hearth and bessemer department. Mr. Zubaly has twenty-seven years' continuous service with J&L, starting as a first helper in the open hearth department in 1923. However, he worked for J&L as a third helper and second helper temporarily before that time. He was promoted to junior melter, senior melter, then general foreman, the position he held before his recent promotion.

Arthur Th. Kathner has been named supervising engineer for Sheet Steel and Tin Plate Co., Ltd., of Greece. Mr. Kathner will have charge of the improvements to and enlargement of their steel works located at Piraeus (Athens) Greece. His office will be located at 3d Kilometer Thivon Street, Piraeus (Athens) Greece.

John W. Reavis, a member of the law firm of Jones, Day, Cockley and Reavis, Cleveland, Ohio, and a director at J&L, has been elected a member of the executive committee of Jones & Laughlin Steel Corp., Pittsburgh, Pa.

George C. Peters was named to the newly-created position of safety engineer in the office of the supervisor of safety and welfare, for Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Peters was formerly assistant superintendent, safety and welfare at Aliquippa, Pa., works.

Fred E. Haker has retired as director of purchases for Allis-Chalmers Manufacturing Co., Milwaukee, Wis., after 50 years of service with the firm. Mr. Haker is succeeded by **Kenneth R. Geist,** who has served as

HARLES L. McGRANAHAN

DON L. ORTON

B. C. BLAKE

KERMIT L. JOHANNSE

assistant to the director of purchases for the past two years.

James K. Magee has been appointed assistant to superintendent, blast furnace department, at the Duquesne, Pa., works of Carnegie-Illinois Steel Corp. Mr. Magee has been a relief foreman since February, 1948.

JAMES K. MAGEE

Thomas M. Fallon, formerly advertising manager of the machinery division of Dravo Corp., Pittsburgh, Pa., has been appointed publishers' representative of the American Society of Mechanical Engineers. Mr. Fallon will represent the society's two publications, "Mechanical Engineering" and "ASME Mechanical Catalog," in Western Pennsylvania, Ohio and West Virginia.

John J. Kenney has been promoted to assistant superintendent, conditioning department, at the Duquesne, Pa. works of Carnegie-Illinois Steel Corp. Since January, 1948, Mr. Kenney has been assistant to superintendent, blooming mill department.

JOHN J. KENNEY

Robert G. Van Keuren has been appointed chief sales engineer for the abrasive division of Norton Co. Mr. Van Keuren succeeds **A. Oakleigh Bush** who died September 2.

BOOST *ON-GAGE* TONNAGE
with G-E X-ray Thickness Gage

Now, defense demands more production and conservation of materials. General Electric's X-ray Thickness Gage by continuously gaging moving strip, enables you to—

ROLL FASTER—One mill replaced mechanical gages with G-E X-ray Gages and upped rolling speed 45%. Scrap decreased despite the speed increase.

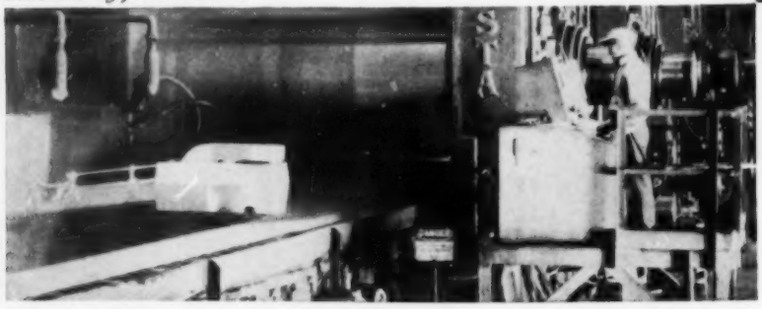
SAVE MATERIAL—Another mill now reaches gage on the first strip. Before, as many as four strips went through before gage could be reached.

HOLD CLOSER TOLERANCE—This same mill now gets more uniform strip and says the G-E X-ray Gage will pay for itself many times.

Perhaps you can get results like these with a G-E Thickness Gage. Why not ask your G-E salesman to discuss its application in your mill?

For more information write to Section 687-60 for bulletins GEC-471 and GEC-485. *Apparatus Dept., General Electric Co., Schenectady, New York.*

▲ HEAT, STEAM, OXIDES—EVEN STRIP COBBLES—do not affect detector head of G-E Gage, here shown in position on continuous hot-strip mill.

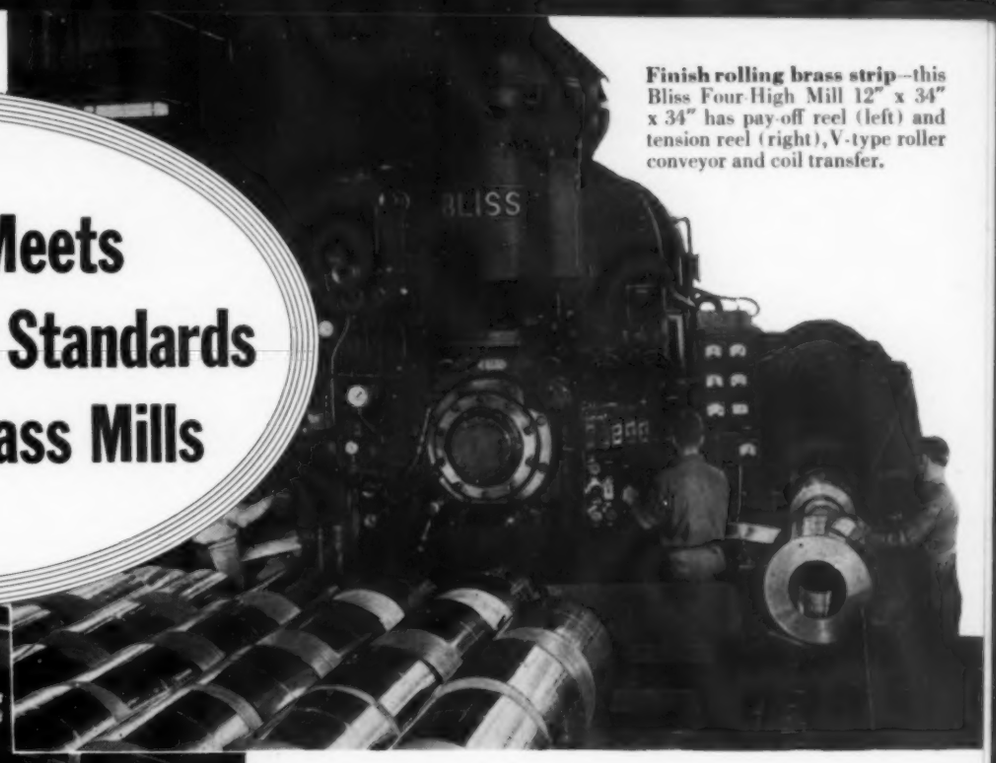


◀ G-E X-RAY THICKNESS GAGE on continuous hot-strip mill. Operator watches an indicator which shows deviation from desired thickness and can make screwdown adjustments during rolling.

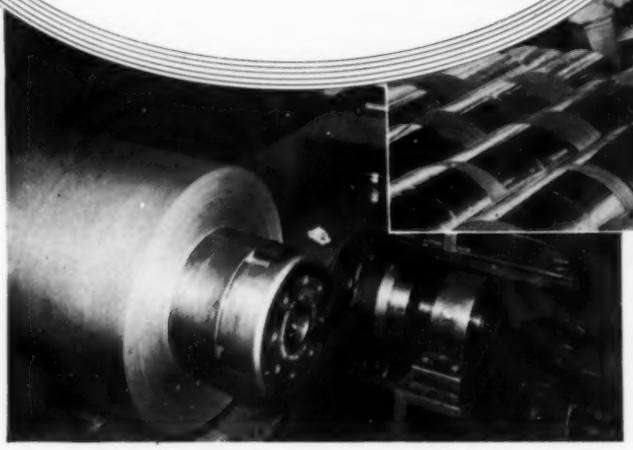
GENERAL ELECTRIC

687-60

How Bliss Meets Exacting Rolling Standards at Western Brass Mills



Finish rolling brass strip—this Bliss Four-High Mill 12" x 34" x 34" has pay-off reel (left) and tension reel (right), V-type roller conveyor and coil transfer.



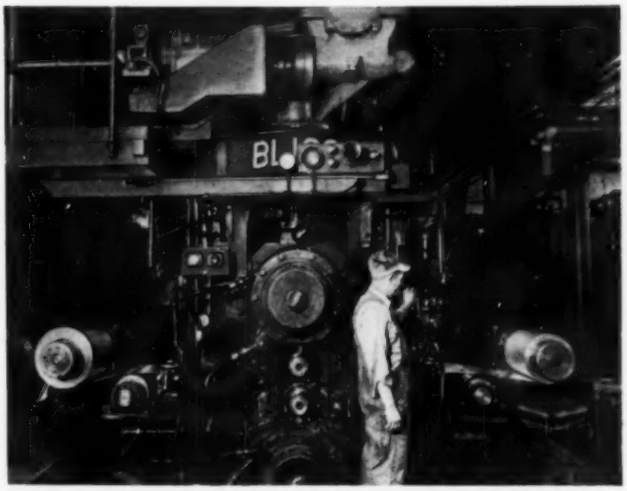
Close-up of tension reel, Billy roll and thickness gauge on Bliss reversing mill illustrates rugged design of all components.

2000 tailor-made mill runs every month in varying widths and gauges of copper, brass, nickel, nickel brass, leaded or silicon brass and bronze...that's the production schedule for several Bliss breakdown and finishing stands at Western's East Alton, Illinois, mill. Moreover, all Western metals are custom-made to specifications...uniformly smooth-surfaced sheets and strips —true to gauge.

These frequent change-overs and precise requirements demand the rugged four-high mills with the full complement of controls and adjustments which Bliss engineers so amply provide. 95% of all the metal produced at Western Brass Mills, a division of Olin Industries, Inc., passes through the Bliss two-stand finishing mill.

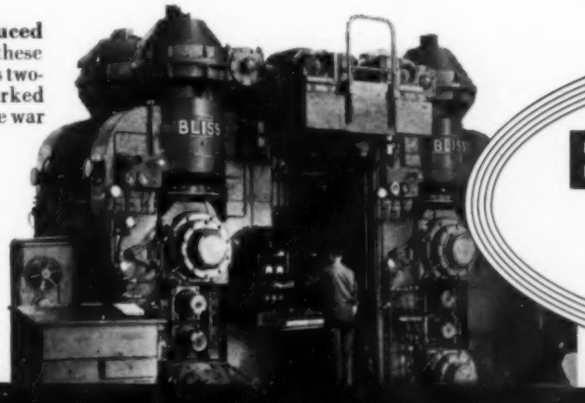
Practical, performance-tested, material-handling devices of advanced design are at work on all Bliss mills —pay-off reels, coil entry conveyors, st ker guides, tension reels, roller conveyors, Billy rolls, coil hoists and many others.

Your metal production, ferrous or non-ferrous, may benefit from new Bliss equipment—rolling mills and accessories, hot or cold. There's a good chance that Bliss engineers, who created many of the metal-producing industry's "firsts," will have the right answer for you.



Reversing finishing mill—Bliss four-high with two tension reels, Billy rolls, coil hoists with V-type conveyor rolls and stripper plate.

95% of all metal produced at Western passes through these mills. Installed in 1942, this two-stand, four-high mill worked 'round the clock during the war and double shifts since.



E. W. Bliss Co.

General Office: Canton, Ohio

Rolling Mill Division

Salem, Ohio

SPECIAL TUBE MILL ROLL
AJAX DUPLEX ROLLS
SUPERIOR "X" ROLLS
LEWIS
ROLLS
OVER 90 YEARS
LEWIS
OF ROLL MAKING
"X" and "XA" ROLLS
SPECIAL PROCESS ROLLS
meet the most exacting
Roll specifications
MANUFACTURERS OF
ROLLS AND ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES
MOLYBDENUM CHILLED IRON ROLLS
PLAIN CHILLED IRON ROLLS
ATLAS and ATLAS "B" ROLLS
CLIMAX and AJAX ROLLS
LEWIS FOUNDRY AND MACHINE DIVISION OF BLAW-KNOX COMPANY · PITTSBURGH, PA.

Arthur H. Lauder has been appointed manager of engineering of General Electric's large motor and generator divisions at Schenectady, N. Y.

Charles H. Good, Jr., succeeds **Kermit L. Johannsen** as superintendent (assigned and operating) maintenance at Carnegie-Illinois Steel Corp., Duquesne, Pa.

CHARLES. H. GOOD, JR.

Mr. Good has been assistant superintendent (assigned and operating) maintenance since September, 1948.

Harold Green was appointed assistant superintendent, electric furnace department, at the Duquesne,

HAROLD GREEN

Pa. works of Carnegie-Illinois Steel Corp. Since January, 1948, Mr. Green has been assistant to superintendent, electric furnace department.

Philip C. Neumann and **William C. Campbell, Jr.,** graduate electrical engineers, have been newly named as sales representatives in Allis-Chalmers Pittsburgh, Pa., district office. Mr. Neumann served in Allis-Chalmers switchgear section from 1940 until 1949 when he left to become a manufacturer's agent. At that time he was assistant sales engineer in charge of switchgear. Mr. Campbell joined Allis-Chalmers in 1939 and in 1940 was assigned to the company's New York office. In February, 1941, he was transferred to the Knoxville office where he served until September when he entered the U. S. Army. Upon his discharge in 1946, he became vice president of the Campbell Contracting Co., Columbus, Ga. He returned to Allis-Chalmers in March, 1950.

Link YOUR BRUSH PROBLEM TO
MORGANITE experience
MORGANITE CARBON BRUSHES
MORGANITE engineering service — backed by years of specialized experience in motor and generator brush manufacture and application — assures competent, practical collaboration in solving any brush problem. For prompt help in the selection of the proper brush for your needs, or for quotations on brushes to your specifications, call or write MORGANITE
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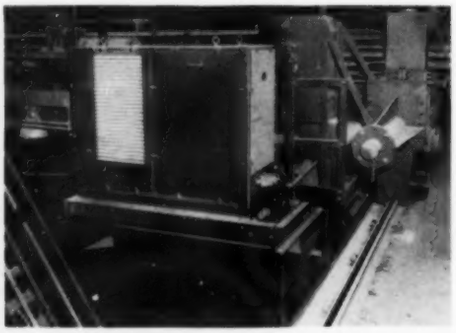
Manufacturers of Morganite Self-Lubricating Carbon Specialties including Seals, Rings, Valves, Slides, Bearings, etc., and Carbon Piles

compact, efficient
LINTERN AIRE-RECTIFIER
requires but little space

1.

THIS IS THE CAB (6' x 6'), in a large modern plant, which has been air conditioned with a Lintern Aire-Rectifier. The operator does his work with ease and accuracy in temperatures of 70°-80° — even on the hottest days when working over the hottest spots.

2.



THIS IS THE CONDENSER UNIT located on cantilever beams over door of the cab — out of the way, and offering no interference with operations. (Can be located wherever desired). It is connected by means of refrigerant lines to the Cab Unit.

3.

THIS IS THE CAB UNIT. It takes only 3 square feet of space and fits easily at the rear of the cab. The operator has plenty of room. It contains the cooling (evaporator) coil, electric heater for winter use, screen type and activated carbon filters. It also includes automatic thermostats and switch for operating the equipment.

The Lintern Aire-Rectifier is a marvel of compactness and efficiency. May we send you the complete story?

THE LINTERN CORPORATION

29-2 RIVERSIDE DRIVE • BEREA, OHIO

Jesse D. Marino has been made works engineer at the Duquesne, Pa., works of Carnegie-Illinois Steel

JESSE D. MARINO

Corp. Mr. Marino has been general supervisor, design and drafting, since May, 1949.

Lawrence L. Garber has been appointed general

LAWRENCE L. GARBER

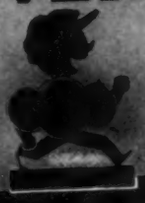
manager American-Fort Pitt Spring division, H. K. Porter Co., Inc., McKees Rocks, Pa.

T. Bruce Carpenter has joined Youngstown Sheet

T. BRUCE CARPENTER

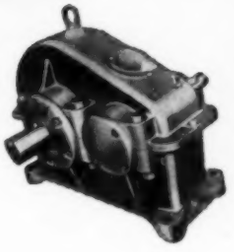
and Tube Co., Youngstown, Ohio, as superintendent of the Brier Hill open hearth department. Mr. Car-

There's a De Laval Reducer for EVERY SERVICE



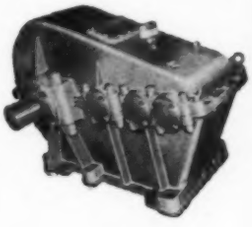
IMO-De Laval Herringbone Gear Reducers

IMO-De Laval Herringbone Gear Speed Reducers are made in single, double and triple reduction units for ratios up to 300 to 1 and for transmitting up to 1000 hp.



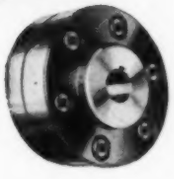
Single reduction

Double reduction



Triple reduction

IMO-De Laval Gear and Crown Couplings

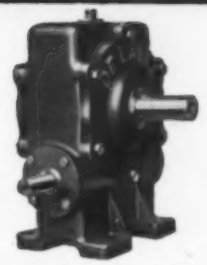


IMO-De Laval Crown coupling.

IMO-De Laval Gear coupling.

IMO-De Laval Worm Gear Reducers

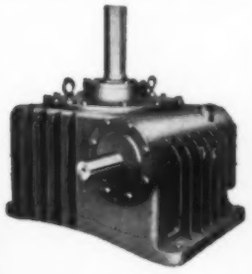
IMO-De Laval Worm Gear Speed Reducers are made in single and double reduction units with ratios up to 8000 to 1 and for transmitting up to 250 hp.



Horizontal, single reduction bottom or top drive in 3" and 3½" center distances.

Horizontal, single reduction bottom or top drive for torque service and moderate overhung loads.

Horizontal, single reduction bottom or top drive, torque or heavy overhung load service.



Vertical shaft, single reduction.

Double reduction worm gear with horizontal shaft.

Double reduction worm and helical with horizontal shaft.

Double reduction worm and helical with vertical shaft.

DE LAVAL

IMO-DE LAVAL PRODUCTS DIVISION

Send for Catalog GWB-26-R.

DE LAVAL STEAM TURBINE CO.

TRENTON 2, N. J.

WG-26

penter succeeds **H. R. Ryan** who recently was appointed superintendent of the company's open hearth department at the Campbell, Ohio, works.

Robert M. Brown was named assistant purchasing agent of National Tube Co., Pittsburgh, Pa. Mr. Brown

ROBERT M. BROWN

started with the company in 1941 as a field auditor. A native of Pittsburgh, Mr. Brown received a degree in business administration from Washington and Lee University in 1936. He served with the United States Army four years during World War II and following the war rejoined National Tube, taking a position in the purchasing department.

Dr. H. K. Ihrig was elected vice president in charge of research, for Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Russell W. McGuire was appointed industrial sales manager for Trion, Inc., McKees Rocks, Pa. Mr. Mc-

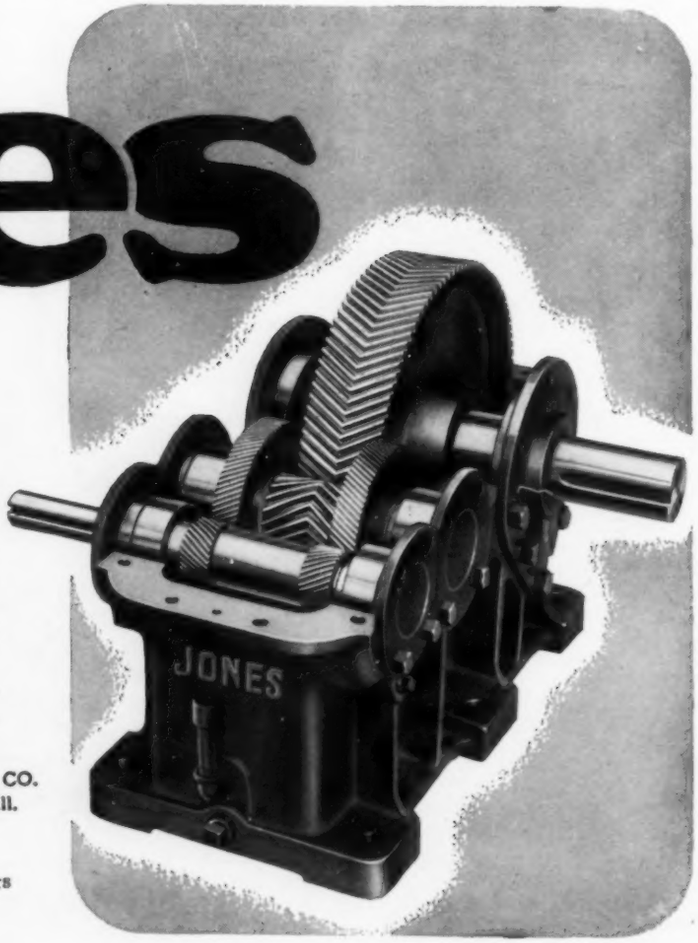
RUSSELL W. McGUIRE

Guire is a graduate of Carnegie Institute of Technology in mechanical engineering. He has been active in industrial sales and engineering work for the past ten years.

William F. Hagen hasbeen appointed by SKF Industries, Inc., as assistant district manager of its New York office.

Jones

Herringbone SPEED REDUCERS-



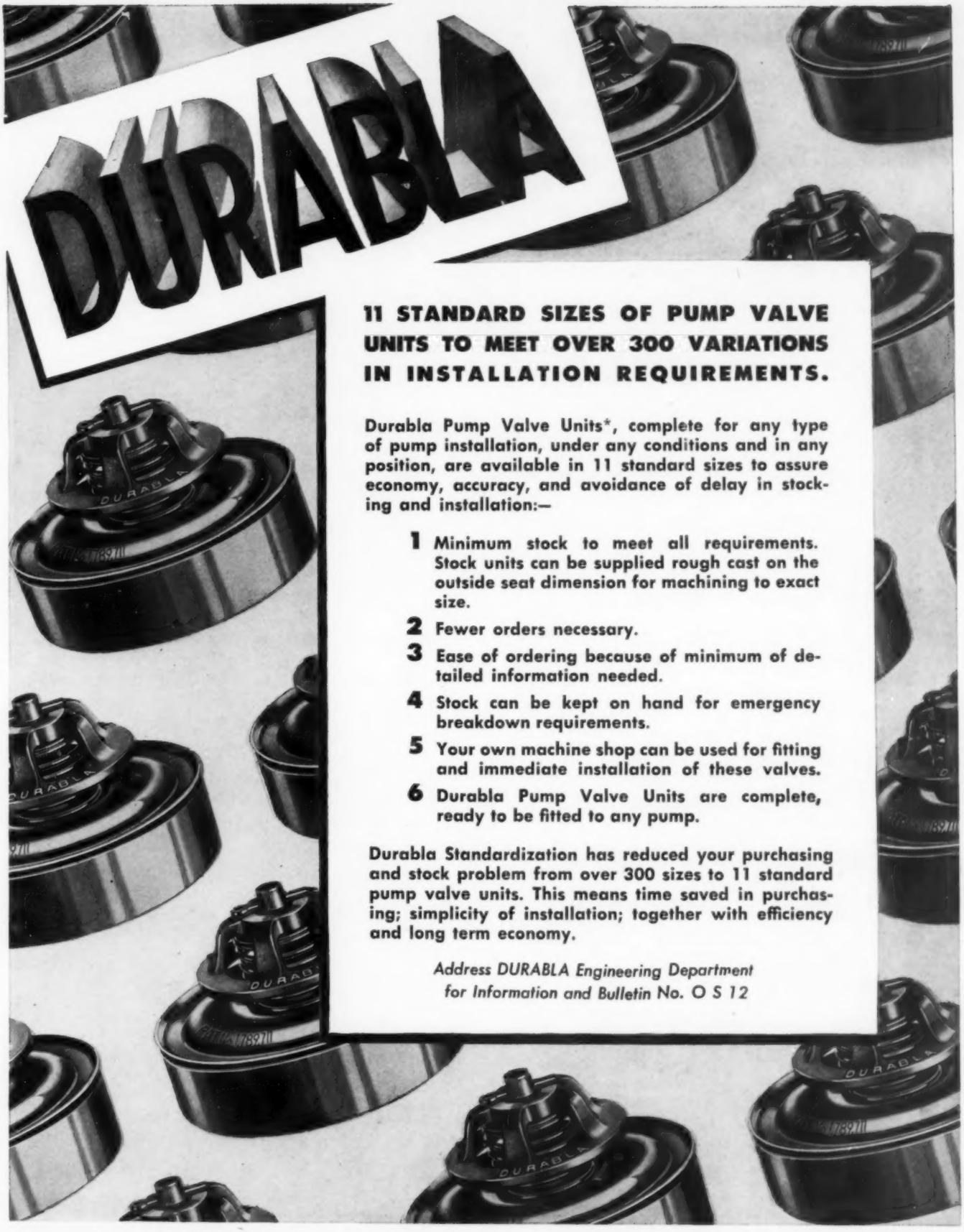
. . . are built in single, double and triple reduction types. Symmetrical gear arrangement provides balanced loads on liberally proportioned bearings. Housings are substantially constructed, well ribbed and have generous pads for foot bolts.

The method of selecting these reducers with complete horsepower and dimension tables is shown in Catalog 70.

Since 1890 Jones In The Service Of Industry

W. A. JONES FOUNDRY & MACHINE CO.
4431 W. Roosevelt Rd., Chicago 24, Ill.

Herringbone — Worm — Spur — Gear Speed Reducers
Cast Iron Pulleys • Cut Gears • V-Belt Sheaves
Anti-Friction Pillow Blocks • Flexible Couplings



11 STANDARD SIZES OF PUMP VALVE UNITS TO MEET OVER 300 VARIATIONS IN INSTALLATION REQUIREMENTS.

Durabla Pump Valve Units*, complete for any type of pump installation, under any conditions and in any position, are available in 11 standard sizes to assure economy, accuracy, and avoidance of delay in stocking and installation:—

1. Minimum stock to meet all requirements. Stock units can be supplied rough cast on the outside seat dimension for machining to exact size.
2. Fewer orders necessary.
3. Ease of ordering because of minimum of detailed information needed.
4. Stock can be kept on hand for emergency breakdown requirements.
5. Your own machine shop can be used for fitting and immediate installation of these valves.
6. Durabla Pump Valve Units are complete, ready to be fitted to any pump.

Durabla Standardization has reduced your purchasing and stock problem from over 300 sizes to 11 standard pump valve units. This means time saved in purchasing; simplicity of installation; together with efficiency and long term economy.

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*Patent Numbers 2090486, 2117504

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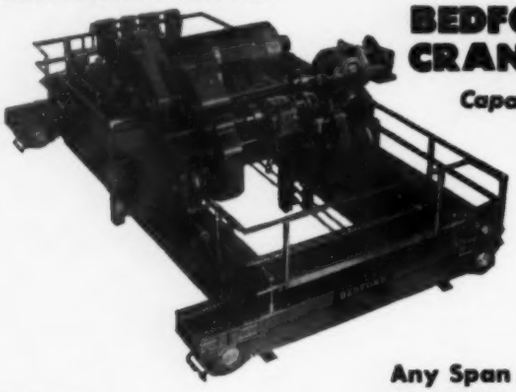
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

CRANE BUILDERS Since 1903



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Capacities 5 to 150 Tons

Any Span or Lift
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Designed and
Engineered to Meet
Your Requirements

ELECTRIC OVERHEAD TRAVELING CRANES
GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

BEDFORD FOUNDRY & MACHINE CO.

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Gray
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BOWSER
ESTABLISHED 1885

Circulating Systems - - - for HIGH SPEED STEEL MILL PRODUCTION

Demands for more steel production and the resulting speed-up of mills require increased circulation of lubricating oils and coolants.

Bowser lubricating systems and engineering service are successfully meeting these demands.

Our experience as the oldest manufacturer of circulating systems will give you the best STAY-ON-THE-JOB insurance a bearing can have.

We'll gladly have one of our engineers call at your convenience. No obligation — just wire, phone or write us.

BOWSER, INC., 1314 Creighton Ave., Fort Wayne 2, Ind.

LIQUID CONTROL SPECIALISTS SINCE 1885

Richard T. Stafford, assistant to the executive vice president of Allis-Chalmers' general machinery division, has retired after nearly 47 years of service.

C. H. Shumard was named district representative for Howard P. Foley Co. in the eastern Ohio district. Mr. Shumard will be located at 311 Bates St., Steubenville, Ohio.

Ervin J. Bookout was named general sales manager of Cochrane Corp., Philadelphia, Pa. Mr. Bookout has been Cochrane's eastern sales manager, and before that

E. J. BOOKOUT

for many years a sales engineer in their Philadelphia territory.

Carl G. Holmes was named to the Pittsburgh district sales staff of Harbison-Walker Refractories Co. A

CARL G. HOLMES

graduate of Penn State College, Mr. Holmes has had 18 years of experience in the sale of insulating and refractory products.

Obituaries

Temple W. Tutwiler, 71, a director of Cities Service Co. since 1930 and a member of its executive committee, and its chief engineer, died November 9 at his home in Birmingham, Ala. Mr. Tutwiler began his career at Tennessee Coal & Iron Co. He served with the 1st Alabama Infantry during the Spanish War, and after that went to work in the Birmingham steel mills. A few years later he was general foreman of blast furnaces at

POSITIVE POWER with PROVED PERFORMANCE

Typical Keystone Double Rail under-running installation, used to operate heavy cranes, conveyors and industrial haulage systems.

Assembly of No. 45813 Standard, No. 45815 Insulator and No. 45814 Clamping Bolts.

KEYSTONE RAIL SYSTEMS PROVIDE ALL-WEATHER INSULATION

Heat or sleet . . . rain or snow . . . indoors or outdoors, you are sure of positive insulation with Keystone Under-Contact Rail Systems—proved throughout the industrial plants of America.

On heavy cranes, ore and coal bridges, unloading conveyors and other types of industrial haulage systems, this under-rail contact system has proved its outstanding value of positive power. The Keystone method of suspending the rail makes it easy to replace a broken insulator without disturbing the balance of the assembly, and as the rail is loose fitting, it is free to contract and expand, thus preventing insulator breakage.

For long-lasting, positive transmission of power, specify Keystone. Write today for the catalog on industrial insulation systems.

Type DD Keystone Contact Rail Insulator for over-running service. Glazed semi-porcelain block insulator. Takes 30- to 100-lb standard rail sections.

Type BO Keystone Contact Rail Insulator for over-running service at 750 volts or less, where great mechanical strength is required.

Type PGB Keystone Contact Rail Insulator, for under-running service. Weather-proof porcelain insulator housing, compact mica insulation.

Types HA and I Keystone Contact Rail Insulator — Cast iron base, cemented at factory to porcelain insulator. All metal parts are hot galvanized.

COLLECTORS, CABLE STRAIN CLAMPS, CONTACT RAIL SHOES

ELECTRIC SERVICE MANUFACTURING CO.

1721 CAMBRIA STREET • PHILADELPHIA 32, PENNA.

U. S. Steel's Gary, Ind., plant. In 1912 he was retained by the Tata's to go to India to complete the construction of iron and steel mills near Calcutta. Upon completion of these works, he was made the operating head and continued in this capacity for 15 years. In 1930 he became a director of Cities Service Co. and in 1936 an executive. Among Mr. Tutwiler's special interests was the famous Tutwiler Hotel at Birmingham, Ala., where he had for some years made his home.

Elmer S. Ward assistant treasurer of United Engineering and Foundry Co., died November 6. Mr. Ward entered the employ of United Engineering in 1917, at one of its Pittsburgh plants, and in 1928 was transferred to the general office accounting department. In 1939 he became manager of the tax, insurance and payroll department, and was elected assistant treasurer in November, 1943, which office he held until his death.

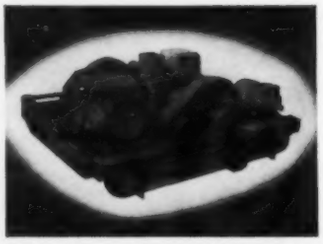
James A. Creighton, 59, superintendent of the steel division of the Bethlehem Steel Co.'s Lackawanna plant, died November 16. A native of Thomaston, Me., Mr. Creighton studied at Bowdoin College and was graduated from Massachusetts Institute of Technology in 1914 with a degree in metallurgical engineering. He first was employed by the Pennsylvania Steel Co., later taken over by Bethlehem. He worked at the latter's plant in Steelton, Pa., until 1926, when he was transferred to the Lackawanna plant. He became superintendent of the steel division in August, 1949.

A. J. McFarland, president of Wheeling Steel Corp., Steubenville, Ohio, died November 28.

HAVE *Strength* WHEREVER STRENGTH IS NEEDED

Satisfying A.I.S.E. specifications, Browning Mill Type Cranes incorporate types of motors and controls on which you have standardized. This flexibility suits your VRB crane *perfectly* to your needs. Our design, springing from 49 years' experience, places plenty of strength where it is required.

Ask for our Bulletin "S".



Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

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Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

COLUMBIA

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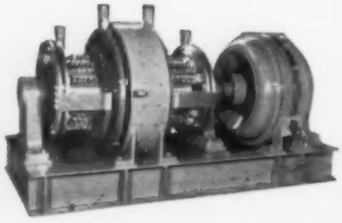

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- TANK RHEOSTATS
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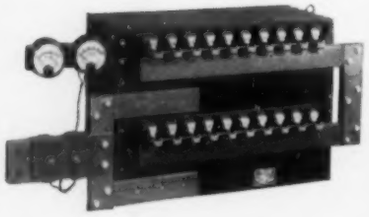

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"Lend me a hand"

JOIN the MARCH OF DIMES
THE NATIONAL FOUNDATION FOR INFANTILE PARALYSIS

This **HOMESTEAD VALVE** opens or closes instantly . . . every time . . . any time

IT'S STICK-PROOF BECAUSE IT'S LEVER-SEALD

HOMESTEAD LEVER-SEALD QUARTER-TURN VALVES have been first choice for more than 16 years in services where extremes of temperature or pressure, or corrosive fluids, cause ordinary valves to "stick" or "seize".

They are "stick-proof" because built into each valve is a powerful lever-and-screw device that prevents sticking and assures positive action at all times under all conditions.

They operate faster too, than screw-stem type valves . . . 16 to 28 times faster. And the quarter-turn principle makes them ideal for installation in restricted areas, next to walls, floors, ceilings, congested piping and other obstructions where other types of valves could not be used. Next time you have a sticking or damaged valve replace it with a Homestead LEVER-SEALD Quarter-Turn Valve. You'll never be satisfied with ordinary valves again.

Homestead Lever-Seal Quarter-Turn Valves are available in metals and alloys to suit your needs in sizes from 1½" to 10" for pressures from vacuum to 1500 lbs.

- **Instant Stick-Proof Operation.**
- **Quarter-turn fully opens or closes.**
- **Seating surfaces always protected. Corrosion practically eliminated.**
- **Unobstructed straight-line fluid flow.**
- **All moving parts protected from effects of service conditions and weather.**

For full particulars send for "Valve Reference Book No. 39-3." Write today.

HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1902"

P. O. BOX 21 **CORAOPOLIS, PA.**

You can make important savings in fuel by taking advantage of the quick heating characteristics of J-M Insulating Fire Brick. These light-weight brick permit a quicker rise to proper operating temperature in the furnace because of their low heat storage capacity, and low thermal conductivity. Where furnaces are being intermittently operated these are two especially important characteristics.

These same insulating materials can also be obtained in large size units called Johns-Manville Insulating *Fireblok*. This product has many advantages over the smaller size fire brick for certain types of jobs . . . from both a construction and stability standpoint. The Fireblok units can be quickly applied because they are easy to cut and fit. Fireblok insulations provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

It will pay you to let a Johns-Manville insulation engineer explain the many ways in which you can save by using these insulations in your furnaces. Just write for further information to Johns-Manville, Box 290, New York 16, N. Y.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage†, percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F †	0.5—0.6 at 2000 F	0.5—0.6 at 2,000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

†24-hr. simulative service panel test for JM-3000; 24-hr. soaking period for other brick.

*Conductivity is expressed in Btu in. per sq ft per F per hour of the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville *first in* **INSULATIONS**

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DECEMBER, 1950

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Motor-Generator

A new 8-page booklet on synchronous motor-generator sets has been announced. The publication covers motor-generator sets from 30 to 8000 kw as a source of d-c power for many industrial applications, such as rolling-mill motors and other drives, electrolytic refining of ores, and excitation for synchronous and d-c motors and generators. The booklet shows four typical installations and describes the construction features of the synchronous motors and d-c generators. Motor ratings include 60, 50, and 25 cycles, 0.8 pf, 220 to 13,200 volts. Generators, both shunt and compound wound, are rated 125, 250, and 600 volts. (GEA-5506) General Electric Co.

(2) Materials Handling Catalog

A new 24-page catalog covering their extremely diversified line of corrugated steel boxes, skids, pallets and combination units has just been published. The new materials handling catalog shows and describes the most recently designed single units as well as the wide variety of skid-box-pallet combinations, and clearly explains their intended uses. Union Metal Manufacturing Co.

(3) Industrial Water Filtration

Methods and equipment for industrial water filtration are illustrated and compared in detail in a new 20-page booklet. Pressure filtration systems are graphically diagrammed in three colors to show application for virtually every industrial use. The text discusses origins of filtration practice and the development of today's filter media and backwashing techniques, including continuous automatic backwashing. Cut-away views, operating data and piping suggestions for single and battery installations are provided for the information of design, process and operation personnel. Featured filtration equipment employs Adams "Poro-Screen," "Poro-Stone" or "Poro-Carbon" filter elements covering the entire range of porosity from .0001 to .004 in. (691) R. P. Adams Co., Inc.

(4) Mill Crane Bulletin

An attractive new 12-page booklet on P&H mill cranes has just been released. The booklet describes and illustrates the many important features of these mill cranes. A large number of photographs, showing typical installations in various mill departments, are included. (C-42) Harnischfeger Corp.

(5) Vibrating Screens

Concentric action vibrating screens for medium and heavy duty service, accurate sizing, thorough rinsing and rapid dewatering of a wide range of materials, ranging from ashes to zinc ore, are illustrated, described, tabulated in a new 12-page book which is now available. The "CA" vibrator mechanism imparts a smooth, positive, circular motion to all screening surfaces. Its amplitude of vibration is easily adjusted to eliminate blinding caused by sticky clays; to speed removal of fines from stones or chemicals; or to insure sharp separation in sizing of ores, aggregates or coal. "CA" vibrating screens are made in sizes ranging from 3-ft wide by 8-ft long to 6-ft wide by 16-ft long screening surface; in single, double or triple deck models; and for suspended or floor mounting. Detailed dimensions, weights, and other engineering layout data are given, including a page on how to select the right size of screen for handling a given capacity of material per hour over square openings of up to three inches. (2354) Link-Belt Co.

(6) X-ray Thickness Gage

A new 8-page booklet describing the x-ray thickness gage is available. This gage is designed to provide a non-contact method of measuring cold-rolled steel strip thicknesses from 0.0050 to 0.1196 in. as it passes through cold mill operations—at the high speeds of the rolling mill, or at the speeds of the slower processing lines. The booklet presents the basic theory of the gage, block-diagramming its electrical circuits to explain its operation. The operator's control, the gaging unit, and the indicator unit are described fully. Complete electrical and mechanical specifications also are given. (DB 404-100), Westinghouse Electric Corp.

(7) Spray Valve

A booklet is available describing one of the hottest items displayed at the 1950 Iron and Steel Exposition—the new Farval spray valve. If you were there you probably saw this new device demonstrated. In any case, you will want to know more about this new development which for the first time makes controlled spraying of lubricant a practical, economical, dependable operation. With the Farval spray valve, either grease or oil can be sprayed onto open gearing, slide surfaces, or any other area where it is desirable to apply a measured amount of lubricant at regular intervals. The spray valve can be operated wherever compressed air is available—either as an addition to a regular Farval "Dualine" lubrication system or in a complete system of spray valves, served by either a manual or an automatic pumping unit. (60) Farval Corp.

(8) New Torch Catalog

Publication is announced of a new catalog on hand torches for gas welding and cutting. This 36-page catalog contains detailed information on Airco's complete line of welding and cutting torches, outfits, tips, and accessories. Extensive charts showing correlation of tip, mixer, extension and torch contain complete data for each component part—a torch and tip for every job. Cutaway views of the

various parts of both welding and cutting torches, as well as welding and cutting pressure charts, make this catalog a valuable reference book. (ADC-702) Air Reduction.

(9) Standard Atmosphere Furnaces

A comprehensive bulletin describing the complete line of Surface Combustion standard rated atmosphere furnaces has just been released. This bulletin shows the five different furnaces, including the "Balco," "Char-Mo," "Atmotrol," vertical and horizontal muffle furnace, and the muffle furnace with cooling chamber for atmosphere brazing. The applications of each of these furnaces to modern, controlled atmosphere heat treating are described in detail. The atmosphere generators, burner equipment and other factors are presented. The compositions of the most widely used heat treating prepared atmospheres and the generators in which they are produced are also described. (SC-148) Surface Combustion Corp.

(10) Adhesives, Coatings and Sealers

Properties of over 100 industrial adhesives, coatings and sealers are tabulated in a new illustrated catalog available to you. The 32-page booklet—"Adhesives, Coatings and Sealers"—announces that more than 1000 formulas are available, and offers research help for industrial customers in selecting the right product for the job. The three tables of properties cover: 64 adhesives for bonding metal, rubber, glass, plastics, fabrics and wood to themselves and to other materials; 18 sealers; and 12 coatings for protecting metal against corrosion and abrasion, for thermal insulation of motor housings, and for sound deadening of metal panels. Also described are strippable coatings. A separate section covers the 15 "Coro-Gard" protective coating systems. Minnesota Mining and Manufacturing Co.

(11) Steel Derricks

A complete line of steel derricks, with capacities of up to 250 tons, is shown in a new 36-page catalog. The six different types of derricks are treated separately in sections which include complete specifications, outline drawings and full page operating pictures. Following these sections are complete construction details from boom point to sill connections. To assist users, one page is devoted to the correct method of determining boom length for lifting a required load to a predetermined height at a given radius. Briefly covered are lifting beams, swiveling fairleaders, blocks and sheaves, as well as revolver cranes and hoists. (200-D-3) American Hoist & Derrick Co.

(12) Valve and Fitting Catalog

Publication is announced of a new stainless steel valve, fitting and accessory catalog. Complete in every detail, this attractive 48-page catalog contains engineering drawings, weights, dimensions, size ranges, materials, corrosion data, nomenclature and design information woven into an easy-to-read and easy-to-follow booklet. The complete line of Cooper Alloy stainless steel, nickel and monel gate, globe, angle, needle, Y, check, tank and other valves; screwed, flanged, welding and forged fittings; flanges, gages, pet and plug cocks, hose fittings and other accessories, is illustrated and discussed. (52) Cooper Alloy Foundry Co.

(13) Water Problems?

Industrial water problems of all kinds—procurement, treatment, usage and disposal—and the facilities and services offered in coping with them are described and charted in a new booklet just published. Pointing up the importance of water in all kinds of industries and industrial operations is a front-cover illustration diagramming the amount of water needed to produce a ton of each of several kinds of products. Various kinds of industrial water problems, and their solution, are described in the booklet, which is entitled "Your Most Important Raw Material." Hall Laboratories, Inc.

(14) Technical Cements

Considered a practical handbook on the application of adhesive cements and compounds, and worthy of careful reading is the exhaustive new Engineers' Production Manual just issued. It contains 64 pages of useful information, with over 150 illustrations, data and charts, and will prove of value to laboratory technicians, production men, engineers and everyone interested in the application of technical cements. Sauereisen Cements Co.

(15) Industrial Temperature Control

In a new 24-page manual the basic principles of industrial temperature control are given in an extremely usable fashion. Entitled, "The Design and Process Engineers Guide to Industrial Temperature Measurement and Control," the study defines the different types of control systems and distinguishes between them so that the engineer can logically select the particular type most appropriate to his situation. First described are: the 8 ways of responding to temperature, the 5 ways of putting that response to work, and the 9 basic Partlow instrument types. Thereafter, the work devotes itself to relative evaluations of systems and the numerous important considerations of application engineering. The manual untangles many confusions which plague the heating engineer, and devotes clear chapters to the neglected subjects of: (1) the influence of the firing system upon the design of the control system, (2) the fundamental tenets of mercury-bulb installation, and (3) the basic concepts of electrical and mechanical control theory. (101). Partlow Corp.

(16) Centrifugal Pump Guide

Economical pumping units for every industry are catalogued in a new 16-page "Handy Guide to Selection of Centrifugal Pumps" just released. A wide variety of units are indexed in this bulletin including close-coupled, pedestal, double suction single stage, multi-stage, self-priming, fractional horsepower, coolant and circulating, fire, process, solids handling, marine, rubber-lined, paper pulp, sewage, axial and mixed flow pumps. Head capacity charts and tables for various types of the pumps are given along with data on sizes, capacities and construction features. (52B6059G). Allis-Chalmers Manufacturing Co.

(17) Electronic Instruments

A new bulletin describing the new strip-chart "Dynamaster" electronic instruments has just been published. The bulletin gives information concerning the new instruments for recording and indi-

cating such variables as temperature, resistance, conductivity, strain, position, inductance, pressure and force. In addition to the recording models, pneumatic and electric-operated automatic control models are also described. The bulletin is liberally illustrated with photos of various models, reproductions of chart records, and schematic drawings. Photographs of several interesting installations of the newly-announced instruments are also included. (W1821). Bristol Co.

(18) Overhead Cranes

A new booklet, available to you, shows a wide range of installations of Northern overhead electric traveling cranes in steel mills, power plants, metal fabricating plants, scrap yards, railroad yards, elecrical shops, etc., with names of representative users of Northern overhead material handling equipment. (G-700). Northern Engineering Works.

(19) Castable Refractory

A bulletin is available discussing a mullite base, castable refractory for use at temperatures up to 3000 F. The booklet recommends this castable refractory for making small special shapes, burner blocks, car decks or car top blocks, monolithic forge furnaces, varnish fire domes, door linings, monolithic furnace linings, front wall of marine boilers and similar applications. The refractory is known as "Taylor Sillimanite Hydrocast." Another booklet is available covering various super-refractory cements. This booklet describes slag resistance, workability, the types available, importance of low shrinkage, and the various types of cements available for the steel industry. A guide to the selection and use of these super-refractory cements is also included. (313 and 314). Chas. Taylor Sons Co.

(20) Standardized Lubrication Systems

A booklet is available on standardized lubrication systems for standardized, centralized and mass lubrication. The booklet discusses various applications of the "Centro-Matic" lubrication system. It also lists the various types of systems and describes the type of control used. Also included are illustrations of the various fittings and pumps used for these systems. Every lubrication engineer should have this in his file. Lincoln Engineering Co.

(21) Optical Comparators

A catalog is available which contains a complete fund of available information relative to all optical comparators in general, in addition to illustrated descriptions of numerous accessories, and methods of inspection by optical projection. The information contained in this catalog includes engineers glass, custom made charts, standard charts, scales and rules, staging fixtures and accessories for use on all makes of optical comparators, measuring, and micro projectors. All persons interested in instrument recording should have this booklet. Engineers' Specialties Division of Universal Engraving and Colorplate Co., Inc.

(22) Plastic Fire Brick

"The Inside Story of Plastic Fire Brick" is the title of a catalog which is available to you. This booklet describes plastic fire brick and its application in industry; it discusses anchors that have been developed after a study of requirements based on actual experience; typical monolithic furnace and wall installations; and applications to boiler furnace construction, suspended arches, etc. Also included is a section on the various specialties available as well as a discussion of their use. Several pages of engineering data on furnace construction and operation is included in this booklet. Laclede-Christy Co.

(23) "12 Considerations . . . .

. . . . You Should Give in Buying Steel Castings" is the title of a booklet that is available to you. It discusses the distance of the customer from the foundry, pattern making, engineering service, steel quality and range of analyses, foundry facilities, heat treating, Hot die pressing, modern quality control, and completeness of machining facilities. Also included is a discussion of various installations put in service by this company. Continental Foundry and Machine Co.

(24) Temperature Regulators

A new 32-page booklet is available containing useful information about pilot-operated pressure and temperature regulators. The booklet discusses main valves, controls and strainers, gives capacity and flow data as well as dimensions and weights. Case example problems are cited to help users select the correct type and size regulator for a particular application. Special sections of the new booklet treat in detail such subjects as thermostats, desuperheaters, electrically-controlled regulators, strainers and flange standards. Spence Engineering Co., Inc.

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51	ASKANIA REGULATOR CO.	BULLETIN 115	Gives the facts on open hearth controls.
52	BAILEY METER CO.	BULLETIN 230-C	Gives the full story on the pyrotron resistance thermometer.
53	BEDFORD FOUNDRY AND MACHINE CO.		Catalog available on Bedford cranes.
54	BLOOM ENGINEERING CO., INC.	BULLETIN 2183	Gives additional information, curves and illustrations of Bloom "Ka-Weld" pipe insulation.
55	BROWNING AND CO., INC., VICTOR R.	BULLETIN "S"	Describes Browning mill type cranes.
56	BUFFALO FORGE CO.	BULLETIN 2424-E	Gives engineering data on rubber-lined exhausters.
57	CITIES SERVICE OIL CO.		Complete facts available on combustion control for industry.
58	CLEVELAND WORM AND GEAR CO.		Tells of worm gear sets and speed reducers.
59	COLUMBIA ELECTRIC MFG. CO.		Descriptive bulletins available on motor generators.
60	DURABLA MANUFACTURING CO.	BULLETIN O S 9	Information on pump valve units.
61	CROCKER-WHEELER DIVISION, ELLIOTT CO.	BULLETIN SL-620-1A	Describes the many exclusive construction features of the W600 series.
62	ELECTRIC CONTROLLER AND MFG. CO.	BULLETINS 1004 AND 1006	Describes EC&M's long life brakes.
63	ELECTRIC STORAGE BATTERY CO.		Bulletin contains latest developments in materials handling.
64	ELECTRIC SERVICE MANUFACTURING CO.		Catalog on industrial insulation systems.
65	FAWICK AIRFLEX CO., INC.	BULLETIN 300	Specific information on all advantages of Fawick clutch and brake units.
66	FURNACE ENGINEERS, INC.		F.E.I. service, complete from plan to production.
67	GENERAL ELECTRIC CO.	BULLETIN GEA-4654	Detailed description on G-E mill motors.
68	GENERAL ELECTRIC CO.	BULLETINS GEC-471 AND GEC-485	Data on G-E x-ray thickness gages.
69	GENERAL ELECTRIC CO.	BULLETIN GEA-3083	Information on G-E metal-clad switchgear for high-voltage applications.
70	HOMESTEAD VALVE MANUFACTURING CO.	39-3	Complete details on Homestead valves.
71	INDUSTRIAL GEAR MFG. CO.	BULLETIN NO. 150	Covers industrial gears.
72	JOHNS-MANVILLE	BROCHURE PK-46A	Describes precision-moulded clipper seals.
73	JONES FOUNDRY AND MACHINE CO., W. A.	CATALOG 70	Shows the method of selecting speed reducers.
74	MAGOR CAR CORP.	BULLETIN DS-102	Gives the facts on Magor air dump cars.
75	OAKITE PRODUCTS, INC.		Answers many questions on metal cleaning.
76	POOLE FOUNDRY AND MACHINE CO.		Catalog available on flexible couplings.
77	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN B-2201	The inside story of the Reliance pre-lubricated bearing design.
78	SQUARE D CO.	BULLETIN 5600	Describes weatherproof installations.
79	TIDE WATER ASSOCIATED OIL CO.		Handbook describes the basic tests used to determine properties of oils and greases.
80	WAGNER ELECTRIC CORP.		Bulletins give full information on Wagner cast iron motors and on other motors in Wagner's complete line.
81	WALDRON CORP., JOHN		Catalog gives advantages of Waldron couplings.
82	WESTINGHOUSE ELECTRIC CORP.	IB 31-280 CS-1 AND CS-2	Describes Westinghouse optimelt-control.

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for steelmaking...

ASKANIA

OPEN HEARTH CONTROL

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★ DEPENDABLE
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★ STABLE
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Askania offers the practical, efficient answer to open hearth furnace control. Askania Automatic Control provides constant heat input, combustion, furnace pressure and automatic reversal control to reduce a number of the variables in open hearth operation.

Typical Applications for Askania Controls for Open Hearth Operation:

1. Control to maintain uniform pressure throughout the furnace.
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3. Combustion Control for single fuel.
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   a. alternate fuels (either oil or gas).
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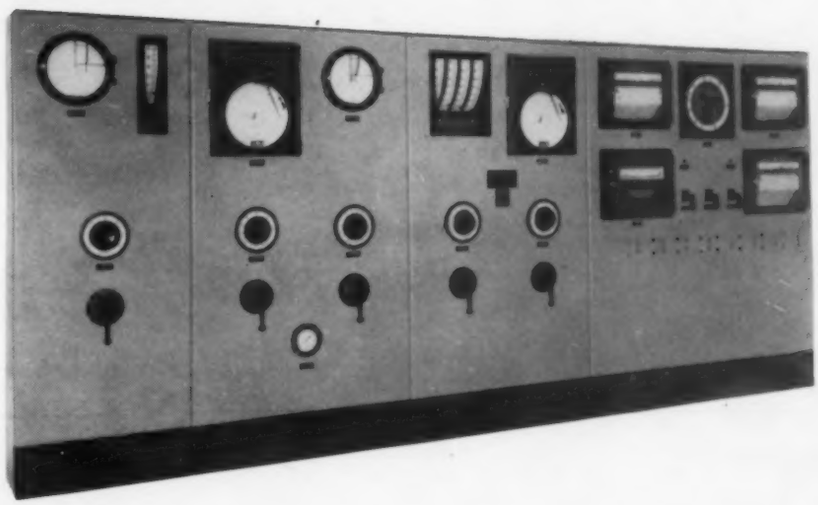
When considering control equipment for your plant get the facts on Askania Controls. Askania's staff of field engineers are available to work with you in solving your control problems.



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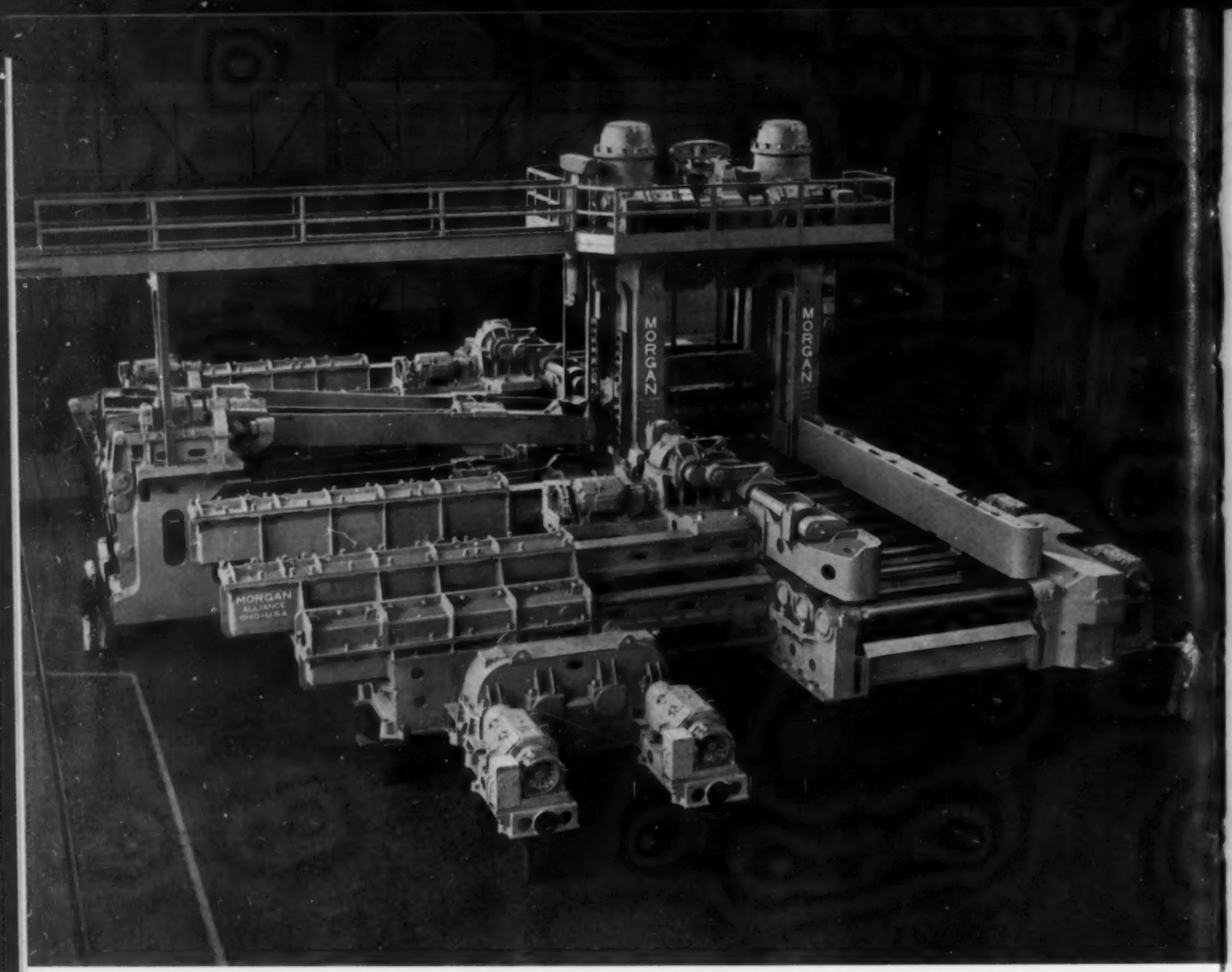

44" TWIN MOTOR DRIVE BLOOMING MILL

Morgan 44"—2 High Reversing Blooming Mill to be direct connected to two 4000-Hp., 50/120 Rpm. Motors. Top roll and both spindles are hydraulically balanced by individual cylinders connected to an air hydraulic system. Speeds of motor driven screw down, feed rollers, mill tables and manipulator are regulated by variable voltage control.

Mill tables have box type cast steel girders. Rollers are forged steel equipped with anti-friction type bearing cartridges. All gears have hardened teeth, are totally enclosed and operate in oil. Manipulator is of the electric overhead type with retractable heads affording maximum accessibility to all parts of the mill tables.

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Equipment News...

METALLIC ZINC PAINT PROLONGS LIFE OF GALVANIZED ROOFING OR SIDING

▲ Throughout industry, the weather resistant values of zinc-coated steel sheets, usually corrugated, have been relied on for generations to provide a long-lasting roofing and siding material. Moreover, plant executives and maintenance men have grown familiar with the convenience and economy of these sections for erecting quickly movable sheds, warehouses, and smaller plant structures.

Because zinc is currently in such great demand, maintenance has become more than normally important; emphasis has shifted to the job of taking care of sheets already in use. The most effective way to add years of life to badly weathered galvanized roofing or siding is to apply metallic zinc paint, which not only stops rust but restores the protection supplied by the original zinc coating so effectively that it has been aptly called "liquid galvanizing."

Hitherto, wire brushing of rusty galvanized roofing has been considered necessary to prepare a perfect surface for the application of zinc paint. Now wire brushing appears to be economically unsound and unnecessary, according to actual field tests recently concluded by the American Zinc Institute.

Perfect preparation of the surface, which is compulsory in most painting operations, would require wire brushing, but years of MZP testing in normal roof exposure in midwest states proves that the results are only slightly better, if any, than those obtained with an ordinary stiff-bristled fiber broom. Certainly it appears that wire brushing fails to increase service life enough to justify the added expense in time and labor.

A typical result: the southern exposure of an extremely rusty roof in Vincennes, Ind., was divided into two sections. One was steel-brushed, the other brushed with a broom, and both were given two sprayed coats of MZP. Seven years later, the difference in the condition of the two sections was almost indiscernible.

Metallic zinc paint, as made by more than 150 manufacturers in this country, is a mixture of 80 per cent zinc dust and 20 per cent zinc oxide in linseed or soybean oil. It is battleship gray in color (unless colors are added), weighs approximately 23 pounds per gallon and covers 600 to 800 square feet per gallon, depending on the condition of the surface. Federal Specification TT-P-641 permits substitution of limited amounts (up to 10 per cent) of coloring materials for an equivalent percentage of zinc oxide. Thus various shades of red, green, buff, etc., may be obtained.

It is theoretically best to paint roofs or sidings of zinc-coated corrugated steel before actual rusting begins — when dark areas are first observed here and there over the surface. With ordinary roofing, this appearance will develop usually after 10 to 12 years' service. However, Institute engineers generally recommend painting when 10 per cent of the surface has weathered sufficiently to show rust. If only spots of rust have developed, give them a coat first, then paint the entire surface.

The best time to paint is in warm, dry weather when the paint will spread well and dry readily. Paint should not be applied when rain is threatened, or when the surface is damp with dew.

Hand brushing is the simpler and quicker method for small jobs. Paint may be brushed out, but the thicker the film (so long as the paint does not run), the longer the life of the zinc coating whose function is to protect the steel sheet.

Where areas of several hundred square feet are to be painted, spray painting is preferable, though coverage will be about 25 per cent less than that gained by brushing — some 450 to 600 square feet per gallon sprayed. Pressures of 75 to 80 psi should be used on the paint line, because the paint is being elevated to roof height. Then, for proper atomization, 100 to 120 psi should be applied to the air line. For best results, an external-mix gun should be used — the type which brings the paint out through a center orifice, and applies air under pressure around it. Trigger the gun at the end of each stroke to avoid piling up the paint in uneven laps.

Wire brushing of roofing is not as effective as popularly supposed.

ALLIS-CHALMERS EXTENDS AIR CONTACTOR LINE

▲ Allis-Chalmers has announced extension of ratings of its high voltage air contactor line (Type 256) for general alternating current motor control applications up to 2500 hp at 5000 volts or 3000 hp at unity power factor.

The new rating of 25,000 amperes for 30 cycles through current now makes it possible to use air contactors in conjunction with back-up breakers rated up to 25,000 amperes interruption capacity or 150,000 kva at 4160 volts and 100,000 kva at 2300 volts.

Since the new contactor can safely pass 54,000 peak amperes, it can be used with non-current limiting fuses rated at 250,000 kva at 4160 volts. This contactor can also be used without back-up protection where system faults cannot exceed 50,000 kva.

The Allis-Chalmers high voltage air contactor line now consists of 200 and 400 ampere sizes for 2500 or 5000 volts with 25,000 or 50,000 kva interuption capacity.

Air break contactors are easy to

maintain, have long lasting contacts, especially for repetitive duty, reduce fire hazards, and require about the same amount of space as a comparable oil-immersed contactor.

IMPROVED CUTTING OIL HAS MANY ADVANTAGES

▲ In accordance with the policy of continually improving the quality and performance of its products whenever possible, the Gulf Oil Corp. has recently improved "Lasupar" cutting oils.

The new and improved cutting oils have the advantages of light color, good transparency, improved cutting ability, and anti-rust properties, while retaining all of the outstanding performance characteristics of the former grades.

Excellent anti-weld properties and load carrying ability are obtained in the new oils by the inclusion of free elementary sulphur, sulphurized mineral oil, and sulphurized fatty oil. The sulphurized fatty oil provides high lubricity and anti-weld properties enabling the oils to produce excellent surface finishes.

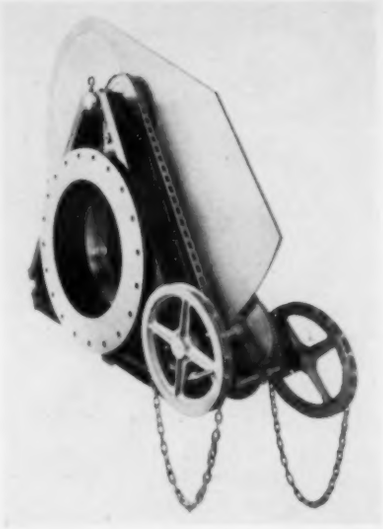
In addition, efficient cooling and extreme pressure properties of these cutting oils permit their use over a wide range of machining operations. They produce excellent finishes on both free cutting and tough, draggy ferrous stocks and alloys.

The new oils are manufactured in a range of viscosities to permit a choice of the proper grade to suit the particular machining job. Selection is based on various control factors, such as, type of metal being machined, cutting feeds and speeds, type and shape of cutting tools, and chip removal.

Field test demonstrations using the new cutting oils revealed as much as 100 per cent improvement in tool life and averaged 25 per cent increase on all jobs over performance of the former brand. Excellent performance was experienced over a wide range of machining operations and operator acceptance was outstanding.

BROSIUS ANNOUNCES NEW GOGGLE PLATE VALVE

▲ Edgar E. Brosius Co., Inc. announces the new Brosius-Westling goggle plate valve which is a redesign improvement over the time-tested Westling valve. This new valve allows



The new goggle plate valve is a redesign of a tested valve.

the fastest positive mechanical operation with new protection against leakage. Higher structural strength has been combined with other new features, and the valve operates so simply that it can be opened or closed by one man in from one-half to three minutes depending on size. The valve can be operated manually or it can be motor driven and interlocked when the service warrants the extra cost.

The "Luminum-Line" Plate and Pipe Marker
IT'S ALUMINUM
50% Lighter than Steel Holders
CARH 73521B
This new "Safety" steel stamp holder of cast aluminum is "easy on the operator" . . . gives long-life, rugged and dependable service . . . for all heavy-duty plate and pipe marking.
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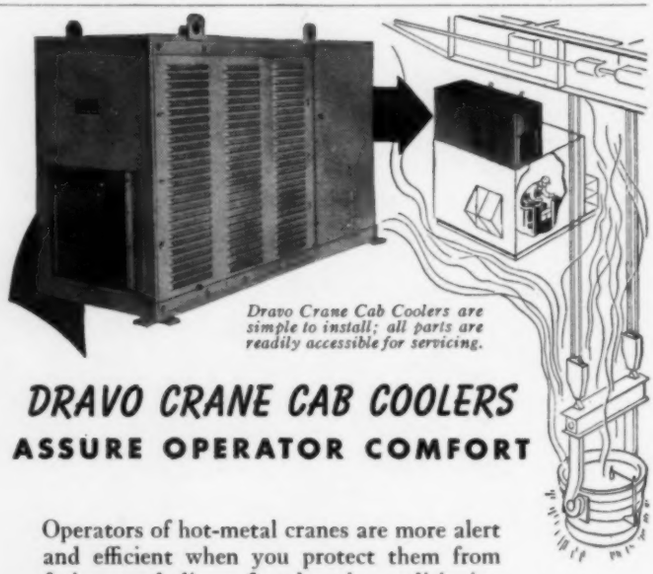
Dravo Crane Cab Coolers are simple to install; all parts are readily accessible for servicing.
DRAVO CRANE CAB COOLERS
ASSURE OPERATOR COMFORT
Operators of hot-metal cranes are more alert and efficient when you protect them from fatigue and discomfort by air conditioning the cabs with Dravo Crane Cab Coolers.
Completely self-contained, and requiring only an electrical connection, the Dravo Crane Cab Cooler provides complete air conditioning:
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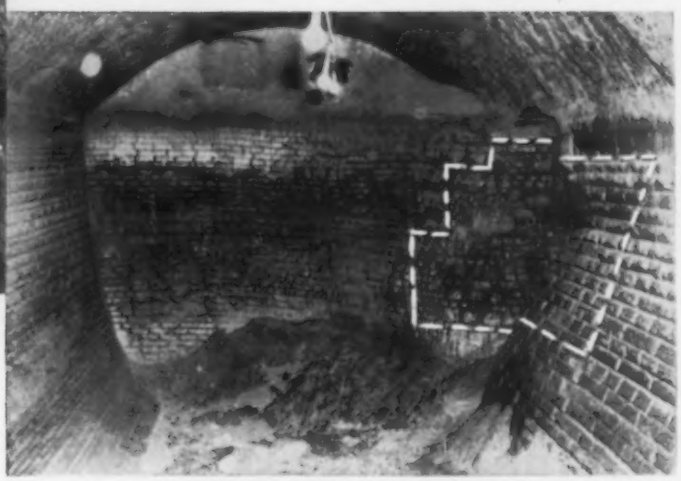
COMBAT JOINT EROSION

and prolong hot metal mixer life with TASIL BRICK AND CEMENT

Area outlined in white shows TASIL brick laid in TASIL cement at start of campaign.



Same section after 6 months and 17 days of service, 259,000 tons through the Mixer. ONLY 25% of TASIL originally installed had to be replaced when repairs were made at the pour-in and pour-out areas. In previous campaign, fire clay brick lasted 3 months, 130,000 tons AND 75% replacement of original lining was necessary.

PROBLEM:

To lengthen the life of Hot Metal Mixer linings so that hundreds of tons of steel are not lost every day the Mixer is down for repairs.

SOLUTION:

Substitute TAYLOR SILLIMANITE (TASIL) brick and cement for blast furnace quality fire brick in the zones of excessive wear—the jambs and bottoms of the pour-out spot, and a band across the front and back walls and across both end walls.

PROOF:

Here's what the Masonry Superintendent of a large Steel Mill has to say about the lining of a 1000 Ton Mixer which had been "balanced" with TASIL in the weak spots and which set a new record for TIME IN SERVICE, TONS THROUGH THE MIXER, and a SAVING IN DOWN TIME AND REFRACTORY COST.

"Although the initial cost was high, the true cost of refractories should not be measured by the price of brick per thousand; the all-important item is the cost per unit of product. With this in mind, the reduced outage and the longer life justified the additional expenditure."

To keep hot metal available at the Open Hearth, call in the TAYLOR engineer in your district for a factual discussion of TASIL possibilities in your plant.

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DEVICE ELIMINATES MANUAL LIFTING

▲ The Riverside Metal Co. reports a simple device which its engineers designed to eliminate manual lifting of 200 lb bars of phosphor bronze, nickel silver, cupro nickel and beryllium copper alloys. Although used at Riverside for this specific purpose, other companies can adapt the design to their products simply by varying the dimensions to fit the products in question. Typical items to which the pick-up element can be applied are rubber, roofing material, lumber, textiles, paper, plastics, and metals.

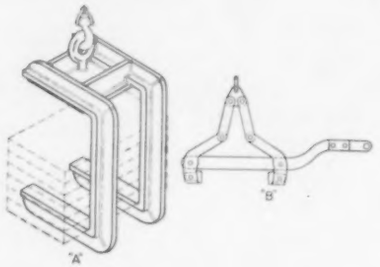
Riverside uses the device to carry 6 bars at a time from sb ars to flat breakdown and from flat breakdown to annealing and back. The 200 lb bars are stacked on pallet blocks and when a load is to be moved, the pick-up device slips under the load, much as a fork truck would, and an electric hoist or crane picks up and transports the loaded element. Previously, bars were hand loaded into lifting mechanisms.

The eye which engages the hoist hook is mounted toward the open end of the device so the center of gravity tilts the load back and "cradles" it, thus preventing it from spilling.

As indicated in drawing "A" the lifting element resembles two giant "C" clamps, welded in parallel. The device is constructed by bending two flats into "C" shapes, reinforcing with additional flats welded perpendicular to the outer sides of the "C" flats, and joining the two by welding connecting members as indicated.

A second device "B" has been designed for handling individual bars when feeding them into or taking them out of machines. This mechanism operates by the tong principle and permits one man to handle individual bars when feeding machines or stacking pallet-blocks. It also was designed and built to solve a specific Riverside problem, but can be applied to other handling problems as well.

Bars are stacked on pallet blocks and loaded in same manner as fork truck loads.



TORCH DESIGNED FOR THIN-GAGE WELDING

▲ A new, lightweight, air cooled "Heliarc" torch for inert gas-shielded arc welding is announced by Linde Air Products Co., a unit of Union Carbide and Carbon Corp. The torch, which has a two-position welding head and needs no water cooling, has a maximum current capacity for continuous duty of 75 amperes. It is designed for welding thin-gage materials.

The new torch, the HW-9, has a torch head and handle assembly weighing only three ounces. In normal welding operations the torch head is at a 120 degree downward angle from the handle, as shown in the accompanying illustration. By interchanging the collet nut and torch cap, which is possible with this torch, the angle of the torch head can be changed

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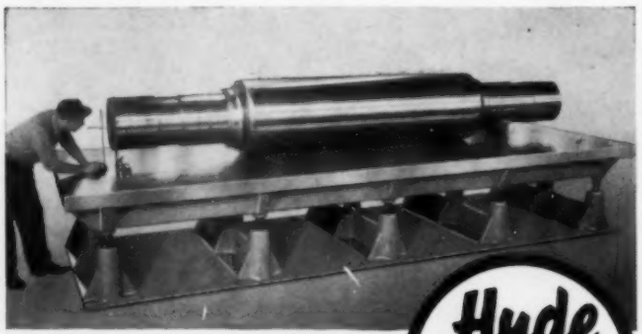

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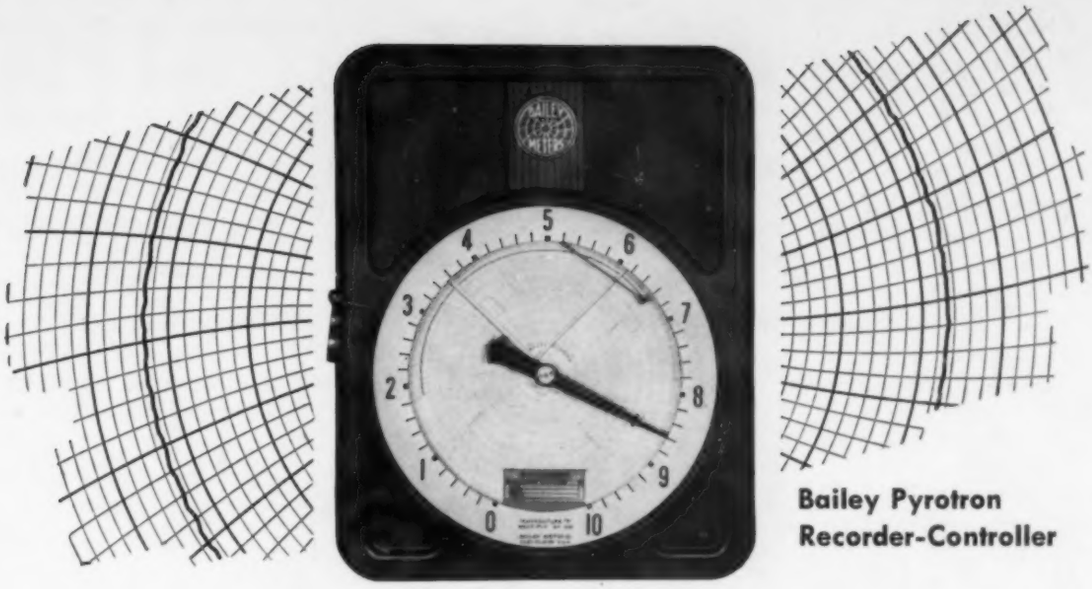

Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

...Then check these features of Pyrotron Electronic Resistance Thermometers...

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

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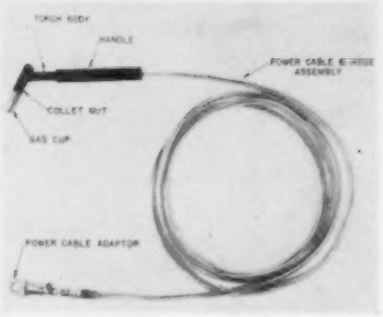
to a 60-degree backward angle from the handle. This permits making welds in tight spots, formerly inaccessible.

The collet nut is part of the torch body in the HW-9, and a quarter turn of the nut frees the electrode from the two-piece quick-release type electrode holder. Steel collets are available for 0.020-in., 0.040-in. and 1/16 in. diameter electrodes. All three sizes of collets can be used with this collet nut. Two torch caps, made of highly heat-resistant ceramic material, are available for the torch, permitting the use of either the 3-in. or 7-in. electrodes.

The torch is equipped with a single cable, carrying both power and gas. The cable supplied is 12½ ft. A 24 ft cable and hose assembly is available as an accessory. The cable has screw-on connections at the torch body and at the adaptor lug, making on-the-job replacement simple.

The entire torch body is sheathed in nylon plastic, safe-guarding the operator from electrical shock. The collet nut is insulated with a molded plastic shield, and other parts of the torch are equally well insulated. This protection allows the use of the torch



A maximum current capacity for continuous duty at 75 amps is possessed by this new torch.

at its maximum rated capacity for long periods of time at great efficiency and without overheating or damaging equipment.

The lightweight, air-cooled torch can be used with either straight-polarity direct current or high-frequency stabilized alternating current.

The torch is expected to be used for welding a wide variety of sheet-metal parts, and should also be valuable in the construction and repair of rocket and jet-engine components.

USE THE ENGINEERING MART

MINERAL WOOL PROTECTS THERMAL INSULATION

▲ Engineers of the Public Service Electric and Gas Co. of New Jersey have adopted a simple, ingenious application technique to reduce the possibility of expansion cracks and accidental damage to thermal insulation on sheet metal air ducts. Block-type mineral wool has been applied to the inside of the large secondary air ducts at the 300,000-kw Sewaren generating station. As a result, repair time and maintenance costs have been held to a minimum; inspection of the lining once a year has been found all that is necessary.

In addition to maintaining the temperature of the 660 F air in the ducts, the internal insulation protects itself from expansion cracks which can occur in external insulation in contact with heated sheet metal surfaces. Protected from cracks and possible damage from accidental contact by plant personnel and equipment, such internally insulated ducts have

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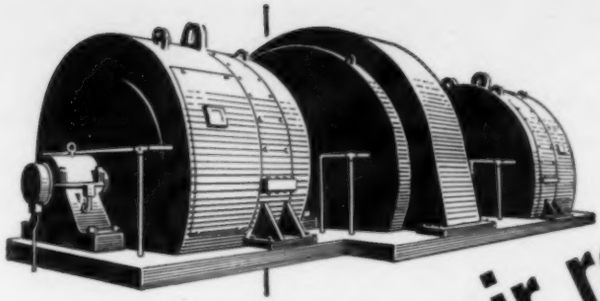
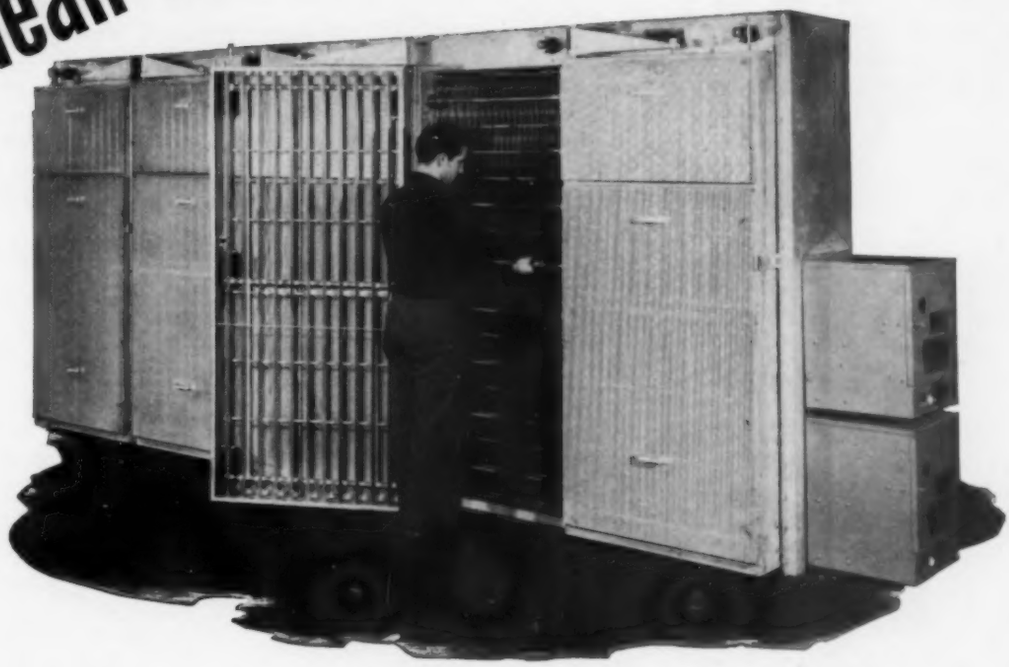


Where clean air returns a cool profit



Today's Best Buy is Better Air!

COOLING mill motors—either by force ventilation or a recirculating system—introduces a serious air cleaning problem. All of the air used with forced ventilation or that portion required for make-up with recirculation must be cleaned. The nature and volume of dust created by steel mill operation makes it necessary to clean any outside air entering the motor room.

This emphasis on clean air has increased the interest in electronic precipitation for steel mill service. The Electro-Cell washable type electric precipitator has proved extremely satisfactory for steel mill applications. Dust, soot and smoke are removed from the air with the highest efficiency. Design featuring removal collector plates offers a choice of maintenance methods—removing cells for servicing in special cleaning tank, manual washing and re-oiling in place or automatic cleaning in place without interruption of operation. Other features such as sectional construction and full-height hinged ionizers make for simplified installation and greater safety.

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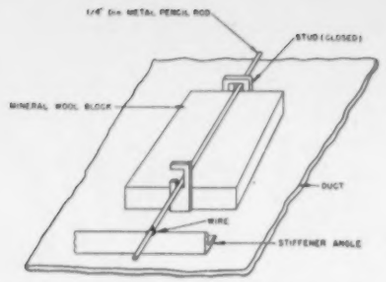


Internal insulation protects itself from expansion cracks occurring in external insulation.

were welded to the duct surface midway between alternate rows of studs and the pencil rods wired to them. The insulating blocks were then painted with a waterproofing material to prevent moisture absorption from the subsequent cement coat. To complete the installation, expanded metal lathe was wired to the pencil rods as a key for a 1-in. thickness of refractory cement.

a better appearance over longer periods.

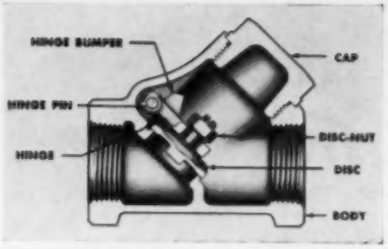
The techniques devised to apply internal duct insulation at the Sewaren station, also useful for external application, were designed to insure a long-lasting, moisture-proof lining. Open rectangular studs were welded to the inside duct surface on 12 in. centers, as shown in the diagram, and mineral wool blocks were slid in between the studs and tightly butted together. Long metal pencil rods were inserted in the stud openings over the insulation. The studs were then closed to hold the pencil rods firmly in place against the blocks.

Stiffener angles on 24 in. centers

REGRINDING CHECK VALVE ANNOUNCED BY CRANE

▲ A new line of Y-pattern brass swing check valves has been announced by Crane Co. The new valves, of the regrinding type, are in the 200 and 300-lb pressure classes. Screwed end patterns are available in sizes ¼ to 3-in., inclusive; flanged end patterns in sizes 1 to 3 in., inclusive.

Many improvements over the usual regrinding check valve are included in the new design. A large cap opening on the same center line as the seat opening permits easy access for regrinding or replacement of parts. Easy contours in the Y-pattern body



The new valves, of the regrinding type, are in the 200 and 300-lb pressure classes.

offer minimum resistance to flow. Closure on backflow is fast and positive.

The new check valves can be used on lines where flow is horizontal or upward. They should be installed with the inlet under the seat, as indicated by an arrow cast on the body.

SHAKER CONVEYOR MOVES BULK MATERIALS

▲ In industrial plants, the movement of materials in bulk for short distances has always posed a problem. Various types of conveyors have been used with varying degrees of success, but there existed a demand

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WHAT'S THE MOST ECONOMICAL WAY?
See page 9
Some good things to know about Metal Cleaning

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for one type that would meet a wide range of conditions and that would be suitable for different materials.

Goodman Manufacturing Co., builders of mining machinery, who for years have designed belt, chain and shaker conveyors for underground haulage where conditions are severe and varied, became interested in the problem. Careful study indicated their shaker type conveyor would be highly adaptable, installations have proved it.

Materials which ordinarily cannot be handled with a belt conveyor are moved with ease by the shaker conveyor. Hot sand and castings, sinter, scale, or rock can be conveyed for distances up to 500 ft at the rate of 100 tons per hour.

The material is conveyed in steel troughs which are designed to fit the particular requirements. The driving unit is equipped with both open and enclosed motors of required voltage.

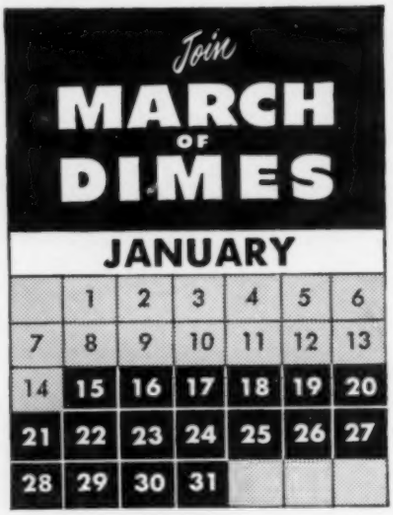
Another of these shaker conveyor installations is at present handling hot coke in a Pennsylvania operation. At times the coke is on fire, but it is successfully conveyed with this equipment.

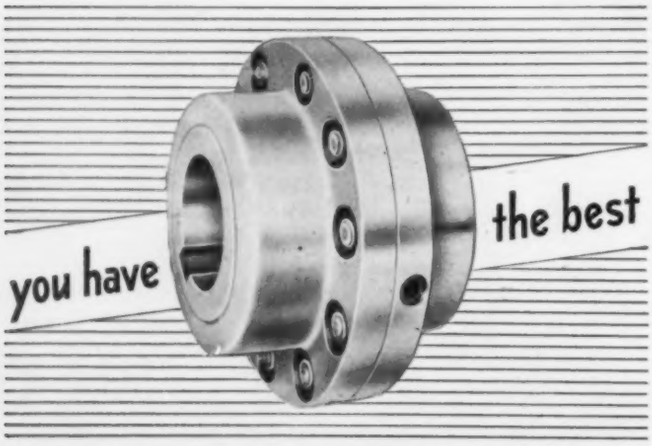
NEW TRAILER HANDLES OILED STEEL SHEETS

▲ For the transportation of oiled steel sheets a 15-ton capacity trailer with a hydraulic tilting rack has been developed by Phillips Mine & Mill Supply Co.

Featured on this tractor-drawn trailer are two removable hydraulically operated tilting racks. After being loaded with oiled steel sheets these racks are tilted toward the center of the trailer by means of a hydraulic mechanism. This tilting feature eliminates danger of oiled sheets slipping off during transport. For unloading, the racks are raised to the normal position by hydraulic cylinders.

Equipped with solid rubber-tired wheels, the trailer has a deck length of 7 ft 6 in., width of 36 in. and height of 24 in.





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Book Reviews

▲ **Treatise on Powder Metallurgy, Vol. II,** Applied and Physical Powder Metallurgy by Claus G. Goetzel, has been issued by Interscience Publishers, Inc., 215 Fourth Ave., New York, N. Y., 6 x 9¼ in., 910 pp, price $18.00. This book is the second of a series of three volumes, the first of which was published about a year ago. The chapters on applied powder metallurgy cover refractory metals, hard metals, electrical and magnetic material, porous products, friction products and ferrous and non-ferrous materials for structural parts and miscellaneous applications. The second part on physical powder metallurgy covers a comparison of physical properties of sintered and fused industrial metals, a survey of possibilities for potential industrial use, stress, analysis of sintered metal structures, appraisal of testing methods, theories of bonding and sintering and an estimate on the future of powder metallurgy.

▲ **"Grundlagen Des Walzverfahrens"** (Fundamentals of the Rolling Process) by H. Hoff and Th. Dahl, 296 pp, 6 x 9 in., 232 ill., 22 tables, in German has been published this year by Stahleisen, Dusseldorf, Germany, price 29 German marks. The book is a good fundamental work on the metallurgy and mechanics of the rolling of metals. The accent is on metallurgy, and about one-fourth of the book is on the rolling process. The book appears to be aimed at the needs of the young metallurgist in a rolling mill plant.

▲ **ASTM Standards on Gaseous Fuels,** issued December, 1949, contains the three standardized tests developed by A.S.T.M. Committee D-3 on Gaseous Fuels. 1. Calorific Value of Gaseous Fuels by the Water-Flow Calorimeter (D-900), 2. Specific Gravity of Gaseous Fuels (D 1070), and 3. Measurement of Gaseous Fuel Samples (D 1071). Copies of this 100-page pamphlet, paper cover, can be procured from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $1.15 each.

▲ **Die Edelstahlerzeugung,** Schmelzen, Giessen, Prufen by Franz Leitner and Erwin Plockinger has been published by Springer-Verlag in Wien 1, Molkerbastei 5, Vienna, Austria, 6½ x 9¾ in., 490 pp, 174 illustrations. This valuable book on metallurgical operations is printed in German and thus its usefulness is limited primarily to those who are familiar with the language.

▲ **Gas Producers and Blast Furnaces,** Theory and Methods of Calculation by Wilhelm Gumz has been published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 316 pp, 5⅝ x 8⅝ in. Price $7.00. The first half of the book deals primarily with gas producers and the second half of the book deals with the blast furnace. Inasmuch as most technology in this field developed along empirical lines, there is a need for the theory and calculations not only to make the process more clearly understood, but also to reveal ways of improvement and new process techniques. They also may help eliminate experiments or directing such experiments with better success. Of particular interest to steel plant personnel is a unique straightforward calculation method for blast furnaces.

▲ **Unit Operations** has recently been published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 8½ x 11¼ in., 611 pp, price $7.50. This book which has been written by twelve authors covers plant operations primarily from the chemical engineering viewpoint. The book emphasizes modern practice and equipment as well as mathematical interpretations, since only through properly designed, constructed and operated equipment can the mathematical treatment yield useful results. The book builds up the student's knowledge and power progressively until he has a fairly clear concept on how to approach the problems of design and operation of processing equipment.

▲ **Fusible Alloys Containing Tin** (24 pp with 15 illustrations), published by the Tin Research Institute, describes the compositions and properties of the tin-containing fusible alloys and illustrates some of their more important industrial applications. This booklet is obtainable, free of charge, on application to: Tin Research Institute, Inc., 492 W. Sixth Ave., Columbus 1, Ohio.

▲ **"Electrostahl-Erzeugung,"** by Sommer and Pollack (Production of Electric Steel), 338 pages, 6¾-in. by 9¼ in., 201 illustrations, 33 tables, has been published recently by Stahleisen, Dusseldorf, 34 German Marks. It is a joy to read this book. After a brief historical review, the authors cover the theories which underlie all electric furnaces, arc, induction, and resistance types. The explanations are clear and understandable. Then follows refractories, with emphasis on those materials which withstand the exceedingly high temperatures of electric furnaces. A section is devoted to constructional details of electric furnaces of all types, and this section is very complete; no detail has been overlooked. The longest chapter deals with furnace operation and with the metallurgy of the process. Particular attention is paid to the effects of 13 alloying metals, to the application of oxygen, of nitrogen, and of argon, and also to agitation of the bath. This chapter may well be called the heart of the book. The last chapter deals with the economics of the production of electric steel. This chapter contains absolute costs and also a comparison of costs with other processes of steel-making. The bibliography contains 200 items, including Swedish, French, England, and Usayan (U.S.A.) references. (Reviewed by W. Trinks.)

▲ PB 100 814, **Handbook of Human Engineering Data for Design Engineers,** 370 pages including graphs, charts and tables, sells for $5.00 per copy. Orders should be addressed to the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the treasurer of the United States. The handbook, three years in preparation, is the first systematic treatise on the science of designing mechanical equipment on the basis of detailed studies of human capabilities. It was written by the Tufts College Institute for Applied Experimental Psychology under a research contract with Navy's Special Devices Center.

▲ **Strength of Stainless Steel Structural Members as Function of Design,** by Michael Watter, Director of Research for the Budd Co., and R. A. Lincoln, metallurgist for Allegheny Ludlum is an unusual departure from familiar stainless steel publications.

This book should prove of extreme interest to engineers and designers working with stainless steel structural members and should go a long way toward filling the recognized need for a method of evaluating the structural characteristics of this useful material. The procedures put forth in the book should allow designers to explore additional applications of stainless steel for airplanes, buses, railroad cars, bridges and similar applications.

As a textbook or reference for designers who are using or planning to use cold rolled high tensile chrome-nickel stainless steel in structures carrying calculated loads, the book presumes a knowledge of mechanics and stress analysis, and therefore will have little appeal for the layman. However, the engineer reader will be richly rewarded by thorough study of this text in that for the first time the stress carrying ability of high tensile stainless steel is explained. A method of stress analysis is developed and checked against empirical results and nomographs are given to aid the designer. The book is cloth bound, 7¼ x 10½ in., 153 pp, price $5.00, and may be obtained by writing Allegheny Ludlum Steel Corp., Pittsburgh, Pa.

▲ **Tinplate Handbook** by W. E. Hoare, 32-pages, published by Tin Research Institute, is of interest to buyers and users of tinplate, particularly if they are engaged in the export or import trade, as it contains all the facts and information they are likely to require and also includes an English-French-German-Spanish glossary of the technical terms of the trade.

The steelmaking and tinning processes used in the manufacture of both hot-dipped and electrolytic tinplate are summarized and the factors which determine the suitability of the various types of tinplate for any particular application are discussed. The major uses of the principal grades of tinplate are indicated and methods of testing mechanical properties, coating thicknesses and lacquer adhesion are briefly described.

The trade terms used by the British and American tinplate industries are defined and methods of grading and classifying the finished tinplates are reviewed.

Gage tables and conversion tables covering a wide range of coating weights and thicknesses will be of value to all tinplate consumers and specimen orders will be useful to buyers who are not thoroughly conversant with modern methods of tinplate production.

This publication is available free of charge on application to: Tin Research Institute, Inc., 492, West Sixth Avenue, Columbus 1, Ohio, U. S. A.

▲ **Standard Metal Directory** has recently been published by the Atlas Publishing Co., Inc., 425 West 25th St., New York, N. Y.; 818 pages; price $15. The 1950 edition is the twelfth edition, and is a complete revision of the old one. The directory is divided into five sections embracing: iron and steel plants; ferrous and nonferrous metal foundries; metal rolling mills; metal rolling plants, and smelters of nonferrous metals. It contains more than 10,000 detailed reports on steel mills, foundries, smelters, rolling mills and nonferrous metal plants, that are located in the United States and in Canada. The plants are listed geographically and alphabetically. The reports give the name of the company, its capitalization, plant equipment, products manufactured, primary and secondary raw materials consumed, names of the company's officers, purchasing agent and sales manager.

The directory also contains special lists of: distributors of pig iron, ores, ferro-alloys; coke ovens in the United States; fabricators and distributors of iron and steel products; metal stamping plants; forging manufacturers; die-cast plants; metal powder producers and sellers; smelters and refiners of primary and secondary nonferrous metals; storage battery manufacturers; galvanizing plants; aircraft manufacturers; automotive vehicle manufacturers; dealers in pipe and rails; scrap iron and scrap metal dealers; importers and exporters; dealers in used structural steel; operators of hydraulic presses; railway purchasing agents. It is a valuable reference for those who are in the steel and metal industries. It is of special value to purchasing agents and manufacturers.

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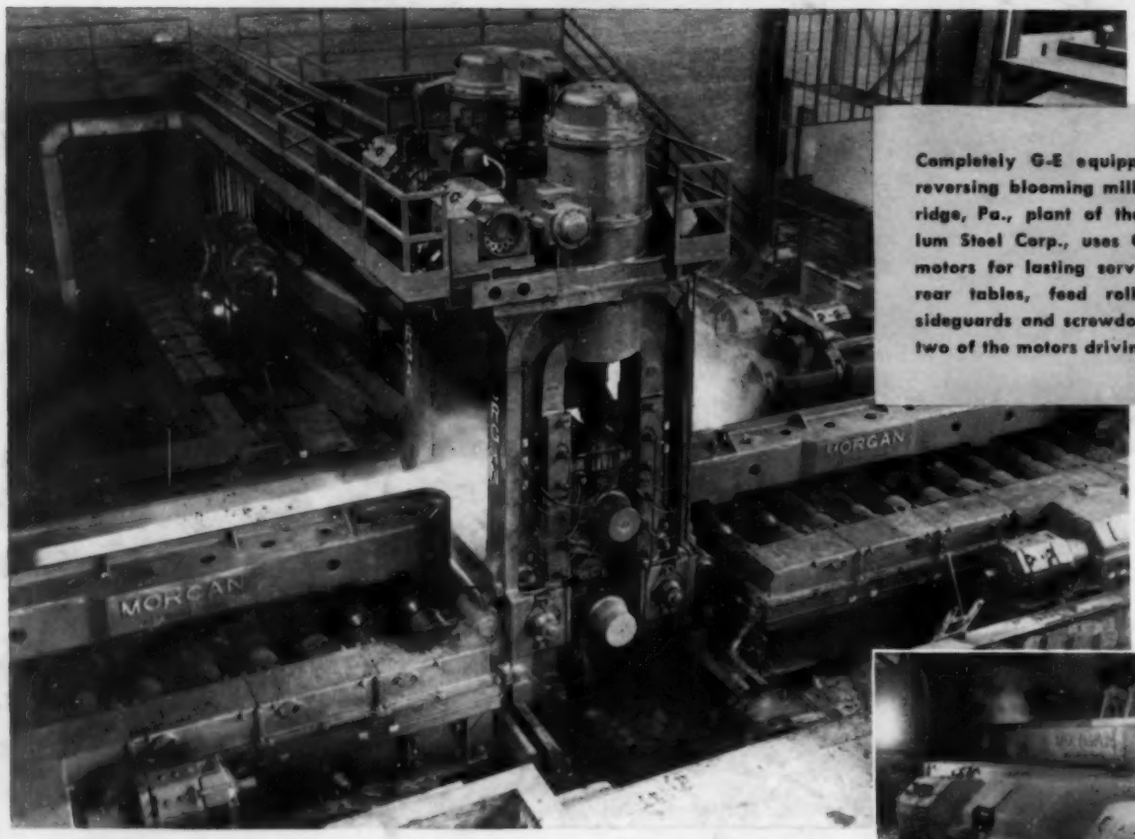

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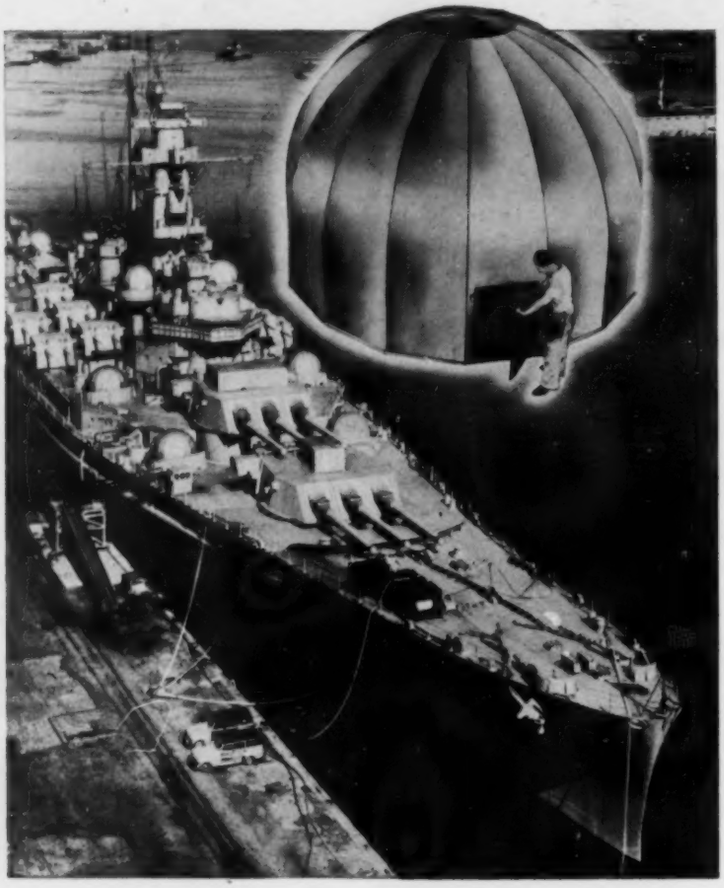

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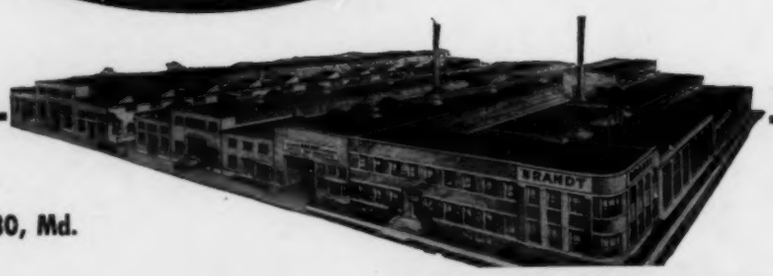

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